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JULY 6-7, 1917

VOLUME XXV

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Burton S. Lanphear...	1914....	October 14, 1904.	XXVI.
Benjamin F. La Rue..	1899....	December 22, 1903.	XII, 243
N. W. Lord...........	1907....	May 23, 1911.	XIX, 507
C. S. Magowan........	1896....	November 14, 1907.	XVI, 406
F. O. Marvin..........	1893....	February 11, 1915.	XXII, 416
Charles P. Matthews.	1898....	November 23, 190 .	XVI, 408
J. W. Muldowney.....	1912....	October, 1916.	XXIV, 340
J. D. Newton.........	1908....	August 8, 1912.	XX, Part II, 490
T. M. Phetteplace....	1903....	September 7, 1913.	XXI, 436
F. H. Robinson........	1894....	January 15, 1916.	XXIV, 341
S. W. Robinson.......	1893....	October 31, 1910.	XXIV, 510
H. A. Sayre..........	1910....		
J. D. Schuyler........	1910....	Sept. 13, 1912.	XX, Part II, 494
Justice M. Silliman...	1894....	April 15, 1896.	VII, 184
A. G. Smith...........	1909....	1916.	
T. Gulliford Smith....	1911....	February 20, 1912.	XX, Part II, 492
H. W. Spangler.......	1893....	March 17, 1912.	XX, Part II, 488
D. W. Spence..........	1914...	June, 1917.	
James H. Stanwood....	1894....	May 24, 1896.	VII, 185
F. H. Stillman.........	1911....	February 18, 1912	XX, Part II, 490
Joseph E. Stubbs......	1897....	May 27, 1914.	XXII, 412
Fred. W. Taylor.......	1912....	March 21, 1915.	XXII, 413
Robt. H. Thurston.....	1893....	October 25, 1903.	XII, 246
Alphonse N. VanDaell.	1897....	March 28, 1899.	VII, 186
J. A. Veazey..........	1911....	August 21, 1911.	XIX, 512
John R. Wagner.......	1894....	January 21, 1899.	VII, 187
Francis A. Walker....	1896....	January 5, 1897.	VII, 188
G. D. Walters.........	1913..	November 5, 1916.	XXIV, 342
H. L. Watson...... . .	1914....	1917.	
Howard S. Webb.......	1897....	June 12, 1905.	XIV, 286
Nelson O. Whitney...	1893....	March 17, 1901.	IX, 339
James R. Willett.....	1896....	May 9, 1907.	XV, 679
De Volson Wood.......	1893....	June 27, 1897.	V, 325
Calvin M. Woodward...	1893....	January 12, 1914.	XXI, 437

FINAL PROGRAM OF THE TWENTY-FIFTH ANNUAL MEETING, WASHINGTON, D. C., JULY 6–7, 1917.

FRIDAY, JULY 6.

9:00 A. M.—Council Meeting, Room "A."

10:00 A. M.—Opening Session.

President G. R. Chatburn, C.E., Presiding.

Greetings from Canada, by A. Stanley Mackenzie, D.C.L., President, Dalhousie University, Halifax, N. S.

A New Organization of Higher Education for National Service, by S. P. Capen, Ph.D., Specialist in Higher Education, U. S. Bureau of Education.

The Consulting Engineer in Public and Private Service, by Hollis Godfrey, D.C.L., Member of the Advisory Commission, Council of National Defense.

12:00 M.—Luncheon.

2:00 P. M.—Afternoon Session.

Military Engineering, by Gen. William M. Black, Chief of Engineers, U. S. Army.

Changes in Our Engineering Courses, by C. S. Howe, LL.D., President Case School of Applied Science.

Canadian Engineering and the War, by Major C. R. Young.

Discussion: Led by F. H. Constant, C.E., and W. G. Raymond, LL.D.

Session closes at 5:30 P. M.

6:00 P. M.—Dinner.

8:00 P. M.

Symposium.—The Placing of Engineering Graduates in Government Service During the War, by William McClellan, Ph.D., Director Inter-collegiate Intelligence Bureau.

Speakers: Henry E. Crampton, Ph.D., Vice-Chairman, Committee on Engineering and Education, Advisory Commission.

John A. McIlhenny, President, Civil Service Commission.

Discussion: Led by I. W. Litchfield, B.S., W. M. Thornton, C.E., Maurice R. Scharff, B.S., F. P. McKibben, C.E.

SATURDAY, JULY 7.

10:00 A. M.

9:00 A. M.—Council Meeting, Room "A."

Certain Relations of a College or University to the Engineering Division of the Municipal Service, by A. H. Blanchard, A.M., Professor of Highway Engineering, Columbia University.

Certain Relations of a College or University to the Public Health Situation, by Lieutenant-Colonel Earl Phelps.

Report of Joint Committee on Engineering Education, by C. R. Mann, Ph.D.

Report of Committee on Admission, by E. F. Coddington, Ph.D.

Report of Committee on Administration, by W. M. Thornton, LL.D.

Report of Committee on Mathematics, by L. C. Plant, A M.

Report of Committee on Physics, by G. W. Stewart, Ph.D.

Report of Committee on Chemistry, by R. M. Bird, Ph.D.

Report of Committee on English, by S. C. Earle.

Report of Committee on Mechanics and Hydraulics, by E. R. Maurer, B.C.E.

Report of Committee on Economics, by J. A. L. Waddell, LL.D.

Report of Committee on Mechanical Engineering, by A. M. Greene, Jr., Sc.D.

Report of Committee on Electrical Engineering, by C. L. Cory, E.D.

Report of Committee on the Standardization of Technical Nomenclature, by J. T. Faig, M.E.

11:00 A. M.

Address by Newton D. Baker, LL.D., Secretary of War.

Address by S. W. Stratton, Sc.D., Director, Bureau of Standards.

12:00 M.—Luncheon.

2:00 P. M.

Engineering Graduates in the Industries During the War. B. G. Lamme, Sc.D., Chief Engineer, Westinghouse E. & M. Co.

Address by Lord Northcliffe of the British Commission.

Address by Christopher J. Phillips, A.B., of the British Commission.

Presidential Address—"Our Patriotic Duty," by G. R. Chatburn, President.

Election of Officers.

MINUTES OF THE TWENTY-FIFTH ANNUAL MEETING.

WASHINGTON, D. C.

JULY 6–7, 1917.

The twenty-fifth annual meeting of the Society for the Promotion of Engineering Education was held in Rauscher Hall, 1034 Connecticut Avenue, N. W., Washington D. C., July 6–7, 1917.

MINUTES OF THE REGULAR SESSIONS.

FRIDAY, JULY 6.

Morning Session.

The meeting was called to order at 10:00 A. M. by President G. R. Chatburn, Professor and Head of the Department of Applied Mechanics and Machine Design, University of Nebraska, who explained the reason for changing the meeting from Northwestern University to Washington. A motion was made, seconded and carried that the action of transferring the meeting from Evanston to Washington be approved.

Dr. S. P. Capen, Specialist in Higher Education of the Bureau of Education delivered an address on "A New Organization of Higher Education for National Service." President Chatburn then introduced A. Stanley Mackenzie, President of Dalhousie University, Halifax, N. S., who

brought greetings from Canada to the Society. President Hollis Godfrey presented his paper on "The Consulting Engineer in Public and Private Service." President Chatburn then appointed the Nominating Committee.

Afternoon Session.

The afternoon session was called to order at 2:00 P. M. with President Chatburn in the chair, who introduced General William M. Black, Chief of Engineers, United States Army. Gen. Black delivered an address on "Military Engineering" which created a lively discussion. A motion made, seconded and carried that this address together with the discussion be printed and distributed as soon as possible. A motion made, seconded and carried that a rising vote of thanks be given Gen. Black for his very inspiring address. Dr. P. P. Claxton, Commissioner of Education, delivered an address on "Engineering Education." Owing to the illness of President C. S. Howe, Dr. Hollis Godfrey presented his paper "Changes in our Engineering Courses" for him. Discussion. Major C. R. Young on the program for a paper, "Canadian Engineering and the War," could not present it as he had been called to the front. Director J. F. Hayford presented the following resolution: "*Resolved*, that a committee of three be appointed by the President of this Society to prepare a resolution addressed to the President of the United States expressing the opinion of this Society that it is desirable that students of engineering should complete their college courses and that it is desirable that such engineering students as are necessarily drafted into military service be placed in positions in which they may render the best service of which they are capable." The resolution was amended to read instead of "addressed to the President of the United States" "a copy should be sent to the President of the United States and the resolution published in our transactions so that our students and professors can all see it." Amendment carried. The original motion as amended adopted.

Friday Evening.

The evening session was called to order at 8:00 P. M. with President Chatburn in the chair. President Chatburn appointed J. F. Hayford, K. G. Matheson and F. H. Constant to serve on the committee provided for by the resolution introduced by Director Hayford at the previous session. He also appointed E. F. Coddington, Anson Marston and H. W. Tyler as a Committee on Resolutions. This session was devoted to the symposium on "Engineering Graduates in Government Service During the War." William McClellan, Director of the Intercollegiate Intelligence Bureau presented a paper on this subject, and the remainder of the evening was taken up with the discussion of same.

SATURDAY, JULY 7.

Morning Session.

The meeting was called to order at 10:00 A. M. with W. M. Thornton, Vice-President, in the chair. The papers "Certain Relations of a College or University to the Engineering Division of the Municipal Service" by A. H. Blanchard, and "Certain Relations of a College or University to the Public Health Situation" by Earl Phelps, were read by title. Dr. C. R. Mann presented the report of the Joint Committee on Engineering Education. Discussion. George Otis Smith, Director of the United States Geological Survey delivered an address on "The Government's Need of Men." Motion made, seconded and carried that the Society express to the Carnegie Foundation for the Advancement of Teaching, the Joint Committee on Engineering Education, and Dr. C. R. Mann, personally, "the very deep appreciation and gratitude for the way in which this study has been conducted, for this most valuable report, upon the issue involved, and also

express officially the request that copies be sent to every member of our Society." Professor E. F. Coddington reported progress for Committee No. 8, Admission. Dean W. M. Thornton reported progress for Committee No. 9, Administration. Professor R. M. Bird made a report for Committee No. 11-B, Chemistry. Vice-President Thornton then introduced the Hon. Newton D. Baker, Secretary of War, who delivered an address, "The Engineer in the War." President Chatburn having returned to the chair, announced that the annual dinner scheduled to take place that evening had been abandoned for the reason that it was impossible to secure enough people to attend to warrant the expense and also the embarrassment of inviting the representatives of the foreign commissions to address about 30 people. Dr. S. W. Stratton, Director of the Bureau of Standards presented an address, "The Work of the Bureau of Standards."

Saturday Afternoon.

The meeting was called to order at 2:00 P. M. with President Chatburn in the chair. The report of Committee No. 12, English, was presented by the Secretary. Dr. J. A. L. Waddell presented the report of Committee No. 14, Economies. Motion made, seconded and carried that the President appoint a committee to consider the question of writing a book on economies and that the recommendation of this committee be submitted to the Council. President Chatburn appointed A. L. Williston, Chairman, M. S. Ketchum and G. F. Swain. The report of Committee No. 20, Standardization of Technical Nomenclature, was presented by the Secretary.

The subject "Engineering Graduates in the Industries During the War" was then discussed. Motion made, seconded and carried that the Committee on Committees be directed to appoint a committee of this Society to co-operate with the National Association of Corporation Schools. The Committe appointed to prepare a resolution to present to the

President of the United States and this Society reported as follows:

"It is the opinion of the Society for the Promotion of Engineering Education in annual convention assembled that,

"WHEREAS, the conduct of the present great war involves not simply military operations at the front, but, of equal importance, the utilization of our resources and the maintenance of our industries,—in order that the production of food and of raw materials, the manufacture of munitions of war and the products needed for the support of our armies and those of our Allies shall be most effective, and

"WHEREAS, to these ends it is absolutely essential that our armies, industries, mines, hospitals and fields should be supplied continuously with scientifically trained men, and

"WHEREAS, the withdrawal of large numbers of undergraduates from our engineering and medical schools for enlistment in the army and in the various forms of government service threatens to cut off the supply of such trained men to the armies and the industries which are so necessary to our military success,

"*Resolved*, that for the most successful prosecution of the war, it is essential that students of engineering shall as a rule complete their college courses, and that such engineering students as may necessarily be drafted for military service should be placed in positions in which they may render the best service of which they are capable,

"*Resolved*, that a copy of these resolutions be transmitted to the President of the United States, the Secretaries of War and of Navy, the Chief of Engineers, and such other public officers as the President and Secretary of the Society may designate."

Upon motion these resolutions were adopted. The Committee on Resolutions reported as follows:

"In concluding the twenty-fifth annual meeting of the Society for the Promotion of Engineering Education, the Committee on Resolutions submit the following resolutions:

"1. *Resolved*, That the Society express the great indebtedness to those officers of the National Government who in a time of unprecedented emergency have generously taken time from weighty public duties to bring in their greetings, to accept our pledges of patriotic service and to advise us as

to the best means of continued co-operation. In particular we acknowledge our obligation to the Honorable Secretary of War, to General Black, Chief of Engineers, to Commander Cluverius of the U. S. Naval Academy, to Commissioner Claxton and Dr. Capen of the Bureau of Education, to Dr. Stratton of the Bureau of Standards, to Director Smith of the Geological Survey, to Commissioner Galloway of the Civil Service Commission, to Counsellor Polk of the Department of State, and not least to Dr. Godfrey of the Advisory Commission of the Council of National Defense.

"2. *Resolved*, That the Society express its grateful recognition of the inspiring message brought in by a representative from another land now united with us in the war for liberty and civilization, President Mackenzie of Dalhousie University.

"3. *Resolved*, That the Society express its cordial thanks to the owner of Rauscher Hall in which our meetings have been so comfortably and commodiously conducted."

Upon motion these resolutions were adopted. The Committee on Nomination then reported as follows:

For President, Milo S. Ketchum, University of Colorado.

For Vice-Presidents, John F. Hayford, Northwestern University.
Ira N. Hollis, Worcester Polytechnic Institute.

For Secretary, F. L. Bishop, University of Pittsburgh.

For Treasurer, W. O. Wiley, New York City.

For Council, T. U. Taylor, University of Texas.
K. G. Matheson, Georgia School of Technology.
C. J. Tilden, Johns Hopkins University.
Frank Aydelotte, Massachusetts Inst. of Technology.
C. F. Scott, Yale University.
W. E. Mott, Carnegie Institute of Technology.
L. M. Hoskins, Leland Stanford Jr. University.

Upon motion the Secretary cast the unanimous vote of the Society for the above named officers. After introducing Dean Milo S. Ketchum as the President of the Society for 1917–18, President Chatburn delivered his presidential address "Our Patriotic Duty." The meeting then adjourned sine die at 5:10 P. M.

MEETINGS OF COUNCIL.

FRIDAY, JULY 6, 1917, 9:30 A. M.

Members present: G. R. Chatburn, F. L. Bishop, W. Hand Browne, Jr., R. W. Gay, C. L. Crandall, W. G. Raymond, E. J. McCaustland, G. C. Anthony, A. A. Potter, W. M. Thornton, T. E. French, F. W. McNair and Hollis Godfrey.

President Chatburn read the budget and expenditures of 1916–17.

President Chatburn presented the following budget as prepared by the Secretary. Regularly moved and seconded that this budget be accepted. Carried.

BUDGET.

From current dues, Individual		$4,800.00
From current dues, Institutional		650.00
From back dues		1.000.00
From advertising		1,000.00
From sale of publications		200.00
		$7,650.00
A. Washington (1917) meeting	$ 300.00	
B. Proceedings, Vol. 25	1,300.00	
C. ENGINEERING EDUCATION, Vol. 8	1,850.00	
D. Committee expenses	150.00	
E. Treasurer's Honorarium	300.00	
F. Secretary's Honorarium	1.000.00	
G. Assistant Secretary's Honorarium	600.00	
H. Clerical assistance	900.00	
I. Sundry printing	200.00	
J. Postage and expressage	300.00	
K. Telephone and telegraph	25.00	
L. Office supplies	100.00	$7,025.00
Surplus		$ 625.00

The application for institutional membership of New Mexico A. & M. College was presented. Regularly moved and seconded that this application be accepted. Carried.

Dr. Godfrey discussed the Canadian situation. Regularly moved and seconded that the Canadian schools be invited to join the Society. Carried.

A motion was made that it was the sense of the meeting that the next annual meeting will be held in Evanston unless conditions arise to make a change necessary. Carried.

Meeting adjourned at 10:00 A. M.

SATURDAY, JULY 7, 1917, 9:00 A. M.

Members present: O. P. Hood, Hollis Godfrey, T. E. French, F. P. McKibben, E. J. McCaustland, G. R. Chatburn, F. L. Bishop, G. C. Anthony, W. G. Raymond, C. H. Crouch, R. W. Gay, W. M. Thornton, A. A. Potter, F. W. McNair, W. Hand Browne Jr.

Moved and seconded that the dinner on Saturday evening be abandoned. Carried.

The application of W. G. Waldo of Vanderbilt Univ. presented. Moved and seconded that it be accepted. Carried.

Moved and seconded that the Society cooperate with the American Association for the Advancement of Science (Section D) with their Pittsburgh meeting. Carried.

Moved and seconded that the report of the committee on higher degrees by D. C. Jackson be accepted and printed in the Proceedings. Carried.

Moved and seconded that the Secretary, Treasurer and incoming president be appointed a committee to report to this Council an amendment to the Constitution and By-Laws providing for the duties of the officers. Carried.

Dean Raymond suggested for the consideration of the members of the Council the abandonment of the separate organization of and the separate meetings of the institutional members.

Moved and seconded that the application of Ecole Polytechnic Institute of Montreal be accepted. Carried.

In the absence of the Treasurer, Mr. Wiley, President Chatburn read his report. No action taken.

Meeting adjourned at 10:00 A. M.

SATURDAY, JULY 7, 1917, 5 P. M.

Members present: G. R. Chatburn, G. C. Anthony, E. J. McCaustland, M. S. Ketchum, R. W. Gay, F. W. McNair, C. L. Crandall, F. L. Bishop, A. A. Potter, W. G. Raymond, G. F. Swain, C. H. Crouch, T. E. French, F. E. Turneaure, K. G. Matheson, W. Hand Browne, Jr., and J. F. Hayford.

The application of Wentworth Institute for institutional membership was presented. Moved and seconded that it be accepted. Carried.

Meeting adjourned at 5:15 P. M.

Council Letter Ballots.

July 12, 1916.—H. C. C. Bray, H. W. Brown, A. J. R. Curtis, F. G. Perry, W. LeConte Stevens. (5)

August 28, 1916.—Wm. Baum, S. E. Brasefield, K. M. Taylor. (3)

November 23, 1916.—J. M. Evans, J. W. Harvey, H. H. Hillegass, S. C. Hollister, J. O. Jones, A. E. Kennelly, Edgar MacNaughton, K. G. Matheson, H. C. Parmelee, J. H. Pound. Rose Polytechnic Institute. (11)

December 28, 1916.—C. F. Duffy, J. H. Dunlap, R. M. Green, J. W. Haney, G. A. Hofman, J. O. Keller, D. M. Logan, E. L. McGrath, T. J. MacKavanaugh, H. E. Nold, Abraham Press, G. M. Osborn, A. J. Scullen, Delaware College. (14)

January 20, 1917.—G. H. Bainbridge, W. H. Bates, Vannevar Bush, H. V. Carpenter, C. E. Corbin, R. H. Dearborn, G. E. Eaton, T. W. Edmondson, E. D. A. Frank, A. S. Gwiadowski, W. D. Halsey, C. M. Newman, C. E. Rogers, W. W. Rusk, M. F. Sayre, D. P. Savant. (16)

March 7, 1917.—W. E. Bullock, J. H. Dorroh, Dawson Dowell, L. W. W. Morrow, F. H. Probert, J. H. Robert, G. P. Springer, E. R. Stivers, University of Toronto. (9)

September 19, 1916.—Letter ballot on meeting with the American Association for the Advancement of Science in New York, December 26–30, 1917.

December 28, 1917.—Letter ballot on dates for the 1917 meeting at Northwestern University.

April 20, 1917.—Chester Allen, Robin Beach, R. A. Brown, W. J. Carrel, L. B. Chapman, E. S. Davis, Stanley Dean, Ira M. DeLong, W. H. Hall, M. R. Hammer, E. G. James, C. A. Mann, C. L. Mann, R. M. Mathews, F. A. Mickle, J. E. Shepardson, O. W. Silvey, W. C. L. Trinks, D. S. Trowbridge, C. F. Wills, Oregon Agriculture College, Catholic University of America. (22)

June 23, 1917.—P. J. Kiefer, John J. Light, C. M. McCormick, Luis Matte, R. E. Moritz, C. E. Pearce, H. S. Rogers, H. K. Rubey, R. J. Smith, F. M. Warner, W. J. Wohlenberg, Leland Stanford Junior University, University of Maine, University of North Carolina, Sheffield Scientific School of Yale University. (15)

May 12, 1917.—Letter ballot as to the advisability of cancelling meeting.

May 26, 1917.—Telegraphic ballot in regard to meeting in Washington.

MEETING OF INSTITUTIONAL DELEGATES, FRIDAY, JULY 6, 1917.

At the meeting of institutional delegates there were 53 present with Dr. Hollis Godfrey, Chairman of the Committee, presiding.

Dr. Godfrey presented the following questions:

That a sub-committee be appointed of the institutional committee to act for the institutions on changing the curriculum. This meeting to take place about the first of August and another meeting about the first of September and on the tenth of September a statement sent to all institutions.

What can be done toward making the importance of the profession understood?

TREASURER'S REPORT.

(June 27, 1917.)

(Not complete.)

Receipts.

	Received.	Budget.
Back dues	$ 805.25	$1,000
Current dues	4,137.25	5,260
Advertising and Sale of Publications	1,658.26	1,300
Interest on Deposit	12.87	
Total Cash Receipts	$6,613.63	$7,560
Cash on hand, June, 1916 (Including Life Membership Fund)	1,257.87	
	$7,871.50	$7,560

Disbursements.

	Received.	Budget.
Schedule A—Annual Meeting, June, 1916	$ 193.79	$ 300
B—Proceedings	9.25	1,300
C—Bulletin	1,707.48	1,850
D—Committee Expenses	133.75	150
E—Treasurer's Honorarium	303.79	300
F—Secretary's Honorarium	325.00	1,000
G—Assistant Secretary's Honorarium	250.00	600
H—Secretary's Clerical Assistance	795.10	720
I—Sundry Printing	183.75	200
J—Postage	392.75	300
K—Telephoning and Telegraphing	24.63	25
L—Office Supplies	133.91	100
Annual Meeting, July, 1917	87.69	
	$4,540.71	$6,845

Accounts Receivable:

Members:

Back Dues	$1,824.72
Current Dues	2,290.50
Other Items	13.39
*Non-members	111.95

* Does not include Advertising for June, 1917.

About $1,500 is owing by members who owe $12 or more.

Liabilities:

Due Members	$ 46.60
Due Non-members	3.60
*Accounts Payable	925.00

* Does not include December, January, February, March, April, May, and June Bulletins, which will amount to about $2,400.

Cash:		
Lincoln Trust Co. . . .	669.16	
Life Membership Fund	397.20	
Secretary's Office	150.00	
	$5,456.92	$975.20
Inventory, June, 1917. .	3,193.55	
	$8,650.47	

REPORT OF SECRETARY.

The growth of the Society during the past year has been normal. At the end of the fiscal year, June 30, 1917, there were 1,521 members, 64 of which were institutional. During the year 1916–17 there were 95 applicants accepted for membership, and 78 members resigned or died, making a net increase of 17 members.

The Society was represented at the third annual Conference on Coöperation; the meeting of the American Institute of Mining Engineers; the meeting of the American Road Builders Association; the Congress of Human Engineering; the meeting of the Society of Technical Secretaries; the Astor Dinner to Engineers of America; the meeting of the Illuminating Engineering Society; the inauguration of Wallace Carl Riddick as president of the North Carolina College of A. & M. Arts; and the committee on Academic and Higher Professional Degrees.

There are 1,800 copies of ENGINEERING EDUCATION printed each month, 41 copies of which are sent free to other journals, and 43 copies sent to subscribers other than members. There was $1,850.00 appropriated for ENGINEERING EDUCATION in the budget* of 1916–17, and we are glad to note that the actual cost of publishing was only $1,764.77. The delay in publishing the PROCEEDINGS was due to the difficulty in securing the paper. This volume exceeded the budget by $2.44. There were 50 copies of this number sold to subscribers. There were 250 copies of the third edition of the Syllabus of Mathematics sold last year, many of these sales being directly

due to the courtesy of John Wiley & Sons, Inc., who inserted an announcement of this book in the mail they were sending to the teachers of mathematics. I take this opportunity of expressing the appreciation of the Society for this kindness.

A folder which gives the names of the officers and members of the Council, the origin of the Society, names and duties of the various committees, and other information pertaining to the Society was distributed to the membership in October and included in 2,500 letters to prospective members which were sent at three different times. One December 1, 289 personal letters were sent to delinquents, a list of which was furnished this office by the Treasurer. For the use of the Membership Committee this office furnished a list of all members in each district; prospective members taken from the latest catalogs; all resignations received to date with a history of each man; and a list of possible engineering schools for institutional membership.

1916-17 Budget and How Spent.

	Appro.	Spent.	Over Bud.	Under Bud.
A. 1916 meeting	$ 300.00	$ 217.00		$82.46
B. Proceedings, 24	1,300.00	1,302.44	$ 2.44	
C. *Bulletin*, Vol. 7	1,850.00	1,764.77		85.23
D. Committees	150.00	120.81		29.19
E. Treasurer's honorarium	300.00	300.00		
F. Secretary's honorarium	1,000.00	1,000.00		
G. Assistant Secretary	600.00	600.00		
H. Clerical assistant	720.00	735.00	15.00	
I. Sundry printing	200.00	182.35		17.25
J. Postage and expressage	300.00	334.98	34.98	
K. Telephone and telegraph	25.00	93.07	68.07	
L. Office supplies	100.00	85.04		14.96

OPENING REMARKS.

BY PRESIDENT G. R. CHATBURN.

Perhaps a word with regard to the change in the place of meeting will be in order at this time.

You will remember that last year, at the University of Virginia, it was voted that the meeting this year should be held in the Middle West, at Evanston. Following out this expression, the Executive Committee had worked on the programme, and had it practically completed; in fact, I believe that the tentative programme was in the envelopes, ready to be sent out to the members. We had gone to Evanston; we had conferred with Director Hayford and his local committee there with regard to entertainment, with regard to the programme itself, and everything was in ship-shape. I think that we would have had at Evanston an excellent meeting. The situation there was excellent. The university, as you know, is situated on the banks of Lake Michigan among the trees, with plenty of lawn to sit upon, and everything would have been cool and pleasant.

Then there came the declaration of war. For some time after the declaration, nothing was done. The people of the country seemed to be somewhat lethargic, and paid little attention to it. Later, the Government began asking for men to go to the training camps and a number of university instructors, students and alumni volunteered to go. The colleges became more or less excited. Letters began to pour into the offices of the Society asking that this meeting be disbanded absolutely.

I was opposed to that, for it seemed to me that a time when the Government was in need of our services was really the wrong time for us to give up. I felt that if we disbanded the meeting at Evanston we should at least hold a

conference somewhere, and although it might be much smaller than a regular meeting at Evanston it would be a disappointment to all of the officers and a greater disappointment to the members of the Society if something of the kind was not held. We felt that the needs of our government demanded that the engineering colleges in the United States should do something to help in this hour of need. We did not know what to do. We do not know yet what to do. We believed, however, that something should be done. Therefore, I authorized the Secretary to take a letter ballot of the Council upon the question of holding a meeting, and also upon the question of whether that meeting should be held at Evanston in the regular way, or whether we should transfer it to Washington, in order that we might be near to the seat of government, in order that we might perhaps get the advice of those who know more about the present needs than we do. We felt that these men who are so busy here as officers of the Government, and are working almost day and night at the present time, could not spend two or three days to go out to the Middle West, but that it would be better for us to bring this meeting to Washington, and trust that we might thus get their help in solving questions at present before us.

It so happened that the Advisory Commission of the Council of National Defense had among its members Dr. Godfrey, our first vice-president. Dr. Godfrey invited us to come here, and offered to give us every means within his power of making the meeting a success. He and his secretary and those who are under him in his office have worked faithfully to help us with this programme. They have obtained speakers that we could not have obtained alone; and on the whole they deserve a great deal of credit for their most valuable assistance.

Our secretary, Dr. Bishop, has likewise worked with ardor to make this meeting a success. He, too, has done double work. The assistance of Vice-President Thornton should

also be mentioned. We do hope that we will get enough good out of this meeting here in Washington to pay us for coming here.

I made out for the benefit of the committee a statement of my ideas of what the meeting should attempt. That has been partially followed out in the programme. My thought was that we might be able to get some information upon military engineering and its different phases from those who have had experience in war, and from the War Department; a description of various features of military engineering in its various subdivisions, such as are made by the different branches of the service—for example, field engineering, aviation engineering, manufacture of munitions, food-supplies, transportation, etc.

In reading the accounts of the war in Europe it occurred to me that this is essentially an engineering war—more so than any war has ever been in the past. What coöperation should there be, then, between the schools and the Government? A definite statement by the Council of National Defense as to what the schools can do, of what they want the schools to do, was in my mind. Whether or not we will be able to get such a statement, I cannot say; but we hope that some of the Government officials, before we get through, will tell us just exactly what they want us to do.

There is the question of how we may modify our various curricula and our calendar, perhaps, in order to do the best good in the present emergency; whether we ought to hurry up our work and turn out our men sooner than ordinary, as has been done in some cases at West Point and Annapolis. By hurrying up a little bit, they have graduated their men a little earlier than they otherwise would. We could probably do that same thing by giving intensive work along certain lines, and omitting or eliminating other lines of work which might not be necessary at the present time.

Then there is the question of the utilization of the present equipment of the engineering colleges. If you take the whole of the engineering colleges in the United States, there is a

tremendous lot of equipment, and this ought to be utilized in some way or other. How may it be utilized to the best advantage in the present emergency?

The question of whether or not the Government will continue to furnish our schools with military officers is one that it seems to me is important. I am not sure that we can get a statement from the Government along this line, but there certainly is no doubt but that military instructors may be obtained. While we have heretofore had, in our school, for example, a West Point officer usually of the rank of captain to take charge of the military department, it may now be necessary to put up with others; still it may be possible to secure a retired officer during the next few years, while the younger men are required in the field; and I believe that the Government ought to be urged with all of our power and all of the insistence that we have to furnish us with such officers—either retired officers or those who are disabled so that they cannot go into actual service. These men could do us a great deal of good, and help us to keep up our military organizations in the various colleges. There are some colleges, some institutions, that have not had regular military organizations. These institutions I believe now would be willing to put in such organizations, provided they can get officers of the army to take charge of them.

Then the Government can help us wonderfully, if it will, by furnishing bulletins covering its needs. The Agricultural Department of the Government has in the past furnished a great many such things. I see no reason why the military and other departments interested in the successful prosecution of the war should not, in the same manner, furnish us with bulletins and with publications of various kinds, calling attention to the things which ought to be done now; I am sure the colleges all over the United States will welcome anything of that kind.

The question of bringing graduates into the Government service or into industrial service which is of use to the Government is another point that ought to be discussed at this

meeting if we can get time for it. There is very little need of our turning out men from our schools unless there is some way open for those men to get into the Government service or into other service of use to the Government. In the past, of course, they have simply gone into the industries and sought service for themselves wherever they could find it; but the Government now has come to our schools, especially those schools that have had military departments, and has asked that men from the engineering colleges and from the other colleges volunteer to go to the camps and take places in the Reserve Corps. A great many of these men are now in the camps, and are drilling hard, intensively, for the two or three months necessary, in order that they may show up whether they are worthy of positions in the army or not. If we could have some sort of an arrangement whereby the students could be taken over in that manner, taken into reserve camps, and knew that they could be taken in, I am sure that our schools would fill up rapidly this fall, because there are hundreds of young men who are anxious to go into the service, and are seeking some way by which they can do so.

Of course there will be some of these young men conscripted, no doubt; just how many, we cannot say. The young men are the ones that will probably be called, the older men having dependent families and established businesses are more likely to secure exemption. If the conscription is a matter of drawing lots, a matter of chance, perhaps only about one in eight or ten or twelve will be selected; but if they are taken out by arbitrary selection, there is no doubt but that a preponderance of young unmarried men will be taken. Now, it seems to me that we should have some sort of an arrangement with the Government whereby men in the lower classes, men in the freshman and sophomore years, if they are conscripted, should remain in the service of the Government, but be detailed, we will say, to a college for the purpose of studying during the next year. We must figure upon a war that is to last for several years—

not that I believe this war will last for several years, because I do not; but at the same time it is possible that it will, and therefore it seems to me that everything that is done by the United States Government at the present time in the way of preparation should look well to the future, and we should prepare for a long siege and for a long war and also for the best interest of the Government after the war is over.

I do not, however, want to take up all of the time of this meeting. We have a programme arranged here that is very full, and one that ought to be instructive as well as interesting.

T. U. Taylor: Mr. President, before the next matter is taken up, I move that the action in transferring the meeting to Washington from Evanston be approved. I think this Society ought to go on record in that way.

(The motion was seconded and unanimously carried.)

The President: Thank you, gentlemen. That helps me wonderfully, because we did not know exactly how the change of plan would be received. I wanted to say, however, that the responsibility for the action fell largely upon the shoulders of the President, as he authorized the vote to be taken; and I appreciate greatly this vote of confidence.

GREETINGS FROM CANADA.

BY A. STANLEY MACKENZIE,

President, Dalhousie University, Halifax, N. S.

Mr. President and members of this engineering congress: I consider it a very great honor and privilege to have been asked to say a word to you this morning as a representative from Canada. I think it has come about in a rather indirect way. One of your vice-presidents, Dr. Godfrey, was present in Ottawa at a meeting or conference of all the Canadian universities, and, making a very short address, told us very concisely but seemingly very effectively what the American colleges in general were doing to get ready to be effective in this war. The completeness of the plan of organization that he laid before us was quite startling to us representatives of the Canadian universities; and when Dr. Godfrey then turned around and said that he would like a committee of the Canadian universities to come down and meet a somewhat similar committee of American universities, we felt that we had entirely misconstrued Dr. Godfrey's line of activity. We had known of him as a man in educational matters generally, in literary matters also, but we had not known him as a great humorist.

We realized that we had done nothing; we had never organized our universities nor our university efforts; and we felt very much that Dr. Godfrey was poking fun at us when he said that he would like to see us here in Washington to talk with them. We came, some of us, and had a very pleasant day or two, and learned much; and if we were able to show your representatives that there were a great many things to avoid, perhaps after all, Dr. Godfrey, we may have been of some service. Our history is a history of mistakes. I do not want to be too modest about it at all. They were

rather forced upon us. We went into the war as you might go in for a swim off the end of the wharf when somebody pushes you. You do not take very many precautions as to how you are going to come out or how you are going to stay in; but, being in, we did the best we could from day to day as events turned up.

I think perhaps I will not take advantage of the suggestion that Dr. Capen made, that I tell you some of our experiences. I think it would take too long, and I think you will get it in better condensed form in the little brochure that I understand the committee wishes to put out concerning those things.

As a Canadian, and a representative of a Canadian university, I cannot look into the faces of those who are here before me without asking you to allow me to make a personal reference. As your president suggested, I have spent half of my working life in this country. One short portion, and a very pleasant and profitable portion, of it was spent in an engineering institution, Stevens; so that I feel perhaps with that short connection there, and my present connection with a department of engineering, that I might not be considered as altogether out of touch with the subject-matter which you are taking up in your meetings.

During those many years that I spent here, I thought I had learned to appreciate properly the temper and spirit of America. When we went into this war and we watched what was doing on this side of the line, I could hardly understand that I had been right. You cannot have any conception, I think, of the joy that came to the minds of those of us on the other side of the line, and to myself in particular, for the reasons that I have given, when we knew that the United States was to march along side by side with Canada and the others who had preceded Canada in this war. So it does my heart good to see such a group as this, and to realize that every other such group as this that is meeting anywhere over this country is standing for all that I felt this great people would stand for; and if I got impatient, perhaps some of you also were impatient, and will forgive

that state of mind in an American-Canadian for two or three years.

It is easy to follow up this line of thought; but I want to give my reasons for that feeling of gratification, and it is stronger than that. It is not only the tremendous, almost unmeasurable, material help which you bring to a cause in which we have been engaged for quite a while; but, rather, it is that feeling that we were not humbugging ourselves, we were not hypocritical, when we thought and said that we are in this war not for anything that we expect to get out of it; that we are not in it, either, simply because we are a part of an empire which got in it and we just trailed in behind, nor that we had got into it on some side issue. We felt and said that we were in this war because it was simply a question of those everlasting things we call justice and right. Now, for this country to have come in, with absolutely nothing to gain—I cannot see where you can gain materially, nor do you pretend to think that you can gain materially—but for you to have come in on the same lines simply reassures us that we were not humbugging ourselves, that we were not hypocrites, and that we are trying, as you are trying, not only to maintain those things which we prize, but to place them where they are imperishable.

That, then, is what gives any Canadian great joy and pleasure to meet a group of pure Americans; and it is for that reason that I think I can be allowed to give you the warmest message of greeting as you go on to take up your share in this great work that can come from your Canadian relatives across the line.

I do not suppose that you, unless you get across from Canada or the other side to this country, can appreciate a little note of psychology which comes to us as we come across. The last time I crossed the line into this country, quite a number of months ago, there was tension, there was nervousness underneath the people's faces. Today, what strikes a Canadian coming into your country is the great, peaceful calm that has settled upon you. There is no more tension;

there seems to be no more nervousness or irritability about the thing. You have simply settled quietly down to what you know has to be done, mighty thankful that you have the opportunity at last of doing it.

I said a moment ago that it was not on account of the almost unmeasurable strength that you have that we welcome your entry in the war, but I cannot help commenting upon this to you. When you think what your little stripling Canadian neighbor has managed to accomplish in this war, absolutely amazing to ourselves—you who have never let yourselves out in your history, and what you are going to do now that you are quietly and with rather a horrible calm for your enemies going to let yourselves out, you do not appreciate; far less do the Germans appreciate what the effort of this country is going to be.

I shall only make a remark or two about our Canadian university experiences, the ones that stand closest to the man, to any man, who has to do with the administration of a university—the loss of his boys, as we cannot help calling them, who have gone away, not to return. Now, that is not a thing to be dreaded, only a thing to be expected, but it is a thing that can be done in a right way and in a wrong way. We, with our voluntary recruiting system, were forced, almost, to do it in a wrong way. We had to encourage our students to enlist, because it was a voluntary effort. We could not stand back. We certainly could not discourage them even if we did not back it up by active advocacy that every able-bodied young fellow should go. The result was that they piled in as fast as they could pile into the lists, all the best. All the best went, and so many of them went as privates—fellows with all kinds of good training, the best scholars as well as the best talent; everything of the best went at once, and depleted our universities of the very cream and the very hope of the nation-hood. Now, that was right in a sense, but it was not right that they should go in that indiscriminate way, without thought of where their training and ability could be best applied. That, I know from what I heard Dr.

Godfrey say before, and from what I have realized since I have come down and have heard Dr. Godfrey speak, you will avoid. No boy that has had a training in mathematics or any kind of scientific work, whether it is pure engineering or not, is like an ordinary fellow who has not had that training, though maybe of the same general stock. The latter has not the same opportunities for service; and to put the former just where you could put anybody is the worst kind of lack of economy. That, you will avoid. That, I think, was our greatest mistake.

Now it is almost impossible for a recruiting sergeant to come to the university I represent—and the same is true of most of them—unless he offers them a pretty good type of activity to go into. They go into the engineers, they go into the artillery, and they go into the aviation corps and the signal corps; but it is very difficult to get them now to go into any ordinary other line of military activity. It is in those I first mentioned that they show their ability; and I should like to say, for the benefit of those who are engineers—you all are—that the men who have only had even the beginning of engineering and not a full course, who have even had scientific work in their arts or science course to any extent, or any mathematical work, are prized by those corps so highly that the rapidity of their promotion shows that given a little spirit, which most of our college lads have, they are right in line for promotion and are most valued in the opinion and eyes of the military leaders.

The rapid promotion of the young college boys, of whom I know so many, is astonishing. I might tell you, for instance, that one young lad was called, at twenty-three years of age, to become a major in the Royal Garrison Artillery of England, which is a record. There never before was one who reached a major's appointment at twenty-three years of age, not to speak of the number of medals and decorations he had. That young lad at twenty-three makes a record in the British Army's history in that particular line of activity. That is the sort of boys you do not want simply to put in a

position where they can be wasted. If there is any thought that comes from the Canadian experience, it is to give every college boy a chance to put to test the leadership that is in him and the strength that is in him.

Mr. President, you have mentioned the fact that you extended to the Canadian universities an invitation to become members of this society. I hope they will take advantage of it. There is no difference between us. I would not be able to tell any of you that you are Americans and I hope you could not tell that I was a Canadian if we met each other on the street. Probably if we were sitting at the same breakfast table there would be one way to tell. I would drink tea perhaps and you would drink coffee, and that is about the only difference between Americans and Canadians. There is just one other way. If I were spelling my name and said it ended in "zed-i-e," they would not deliver any goods to me at all here. We never learned to say "zee." Outside of those two differences, I do not know that there is anything that separates us except that imaginary line which they have drawn somewhere and which nobody could find and I hope nobody will want to find.

I will therefore, Mr. President, and ladies and gentlemen, ask you to take the warmest kind of greeting from your Canadian friends and allies, and to ask you to rememb[er] that if in any way we fall short of what you think [we] should do in this war, it will not be that we are letting [up] in any way in our efforts, because you have come in; [it is] simply that your efforts will be so enormous that you [are] going to swamp our poor little miserable efforts to carry on and do our share. I expect that this effort that you are going to make means that we will never have to make another, and if that is so I can only say that the sacrifice that will come to you will be such a one that you will gladly have made it, gladly have had the opportunity of making it, and glad that, if you did not make the first blow, you made the biggest one.

I thank you!

THE ENGINEER IN THE WAR.

BY HON. NEWTON D. BAKER,

Secretary of War.

Gentlemen, this is, as I understand, a Society for the Promotion of Engineering Education. While my time unhappily is exceedingly limited and I must be very brief, I think I recognize the propriety of at least a word from the Secretary of War under these circumstances to this company.

Hugo once said that no great idea had ever been promulgated in the world without having to pass through France to be assimilated and disseminated. I do not know enough about the histories of great ideas to know whether that is a glittering generality or an absolute fact; but I think I do know that the engineer is the bridge from the pure science to business; that he is the place where the genius of the pure scientist meets the practical necessities of everyday life and effects the benefits of scientific inquiry to mankind.

The art of war has always depended upon such science as there was at the time. If we take science out of the war in which we are now engaged, we would be back to the stone age and the javelin. If it be true, and I think it is, that the engineer is the transmuter of the dreams of science into the accomplishment of modern industry and modern civilization, then, from the point of view of the Secretary of War, or, rather, from the point of view of the military necessities of any country, there is an immediate point of contact and, I think, a message which can be given to those who are interested in the promotion of engineering education.

Before attempting, however, to state what I think is the mission of the engineering schools and of engineering education, it may not be inappropriate for me to say—and it is a

truism—that never before in the history of the world have science and engineering been as vital to the conduct of war as now. The headquarters of a general in the field is now composed not merely of adjutants and couriers of a military character, who can carry orders and concert military movements; but every commanding general in this war is surrounded by a group of scientists and a group of engineers, and no important military operation can now be undertaken upon what were at one time purely military considerations. There must be now concerted, for the guidance of the commanding general, the scientific data with regard to the earth and the sky and the waters under the earth. The place of the geologist, the place of the meteorologist, the place of the electrician, the place of the pure scientist, and the place of the constructing engineer is at the council table of the commanding general. Strategy now in war no longer consists of mere movements of masses of men, but it takes into intimate account the accurate and scientific knowledge of the physical surroundings and physical conditions, and that, of course, can be brought to the coördinating judgment of the commanding general only by the aid of engineers.

That is true not only of the actual military operations as they are conducted in the field, but it is true in a very much larger sense of all that goes into the preparation for military enterprise. The army of the United States is, indeed, integrated in all its activities and all its studies with engineering and scientific knowledge.

We have, as you know, in recent times very greatly developed the applications of science in the use and construction of lethal weapons. The electrical engineer is now as much a part of the coast artillery, the great system of coast defense of the country, as is any purely military officer. In our ordnance department, where engineering problems of the very highest importance have to be considered—industrial engineering problems, electrical engineering problems, metallurgical engineering problems—it is essential that there should be highly trained engineers as a part of the actual military service of

the country; and that is of course in greater degree true in the engineering department of the military establishment, properly so-called.

Dr. Godfrey told me, as I came in, that General Black had yesterday made an address to you on the subject of the engineer and the army. I have no doubt you have gotten very much more from him than I could possibly give you, even if I had the time to review that relationship. But the net result of it undoubtedly has been to bring home to your minds the certainty that every branch of the military service requires constant association with and constant assistance from the great engineering professions which are fed by those who are educating in engineering subjects.

That is merely descriptive of a situation, but the thing that you are met here to consider is what contribution is now to be made by these educational institutions, which are devoting themselves to the production of engineers, to the emergency in which the government and the nation finds itself. We are at war with one of the greatest powers in the world, with a power which, at the beginning of the war, was surely the greatest military power on earth. For reasons of supposed necessity our adversary has, as it has seemed to us, reverted and gone back to ancient and, as we believe, barbarous methods of warfare. Our duty is to answer every nation which sets its face backward toward discarded and, we believe, inhuman methods of warfare, by taking an advanced position and bringing to the aid of the government the very latest, most highly developed and perfected scientific attainments and achievements, in order that we may answer our adversary by being wiser in the use of our minds, more skillful in the use of our hands, and by infusing all our preparation for such a contest with superior knowledge and advanced positions of a scientific kind, so that we will overcome in the last analysis by deserving to overcome, by being the highest development of mankind, and by showing that the later reaches of mankind's development are adequate not only to add to the comforts of man in peace times, but to repress aggression in times of war.

If I correctly understand the situation, most of you gentlemen are connected with engineering schools or engineering education of one kind and another. We have in the army a certain number of engineers, but this is no occasion for us to rely upon the handful of technical assistants whom the government has under its constant service. This must be a coordination of all the engineering and scientific talent and ability in the whole country. There must be some heading up of the inventive genius and of the mechanical and scientific knowledge of the country. The man in the trenches who actually shoulders the gun and is face to face with his adversary is doing a more spectacular and, in some ways, a more heroic job; but the man in the laboratory of the scientific school, who is thinking out new processes by which our endeavor may be more effective and in which our soldiers will be less exposed to loses in warfare—in other words, in which we can bring our power to bear with a maximum efficiency upon our adversary, with a minimum of losses to ourselves—is as truly a soldier of the country as though he were in the foremost trench and had a weapon of war in his hands.

So that the first challenge of this occasion to the engineering and scientific schools and minds of the country is to be fruitful of suggestions and devices, to multiply the continuation of their ingenuity so that we can get the latest and best things In Europe the scientific mind is stimulated to an inordinat degree of activity, and the progress in the art of war that made is a progress from day to day, not from year to ye The existing processes have all been abandoned, and ther is almost a lightning-like improvement of invention, all of wch is being fed to the troops at the front for their greate effi- ciency and greater protection. There must be some ...t of response from the scientific and engineering minds this country, and each man may take for himself the roblem which seems most akin to his particular problems and experience. He may, by constant work, study some of he problems which we have to face, and thus make his contibution to

his country's welfare and, as I say, to civilization's salvation by evolving and testing out and bringing to us, in as nearly completed form as may be, such aids to our efficiency and our safety as can be produced as a result of these patriotic conditions.

In addition to that, I think the larger subject of course, is the relation of engineering education and technical education to the prospective needs of the country. We are in need of further accessions of trained young men from the technical schools of this country, to be fed into our scientific departments. Our ordnance and coast artillery are in constant need of large accessions, and they can get them at their very best from the schools with which you are associated or through the agencies of engineering instruction with which you are associated.

There was a time when West Point trained the best engineers in the United States, and I remember when I was a child, before the day of the present full development of the great modern technical schools, when people used to say, at least in the countryside where I lived, of an engineer that he was a very great engineer, he was a West Point engineer. I do not in the slightest degree desire to detract from the value of a West Point education. I think, so far as I am acquainted with it, for the particular purpose for which it is desired, it is fairly modern. It has kept pace with the constant process of improvement, and is attempting all the time to adapt the minds of the young men who are there to the peculiar function they are to serve in society as leaders of men and organizers of military enterprises. To a very large extent the scientific education they get there is of the very highest value to the army of which they are to become members. Yet it is perfectly obvious to anybody that taking young men and giving them four years of as multiform education as is given at West Point, must fail—except in the cases of unusual genius and very special and exclusive aptitude—to produce the kind or product that we get from one of our great engineering schools, in which a man, after he has completed his academic studies,

undertakes a long and devoted course of specialization along particular engineering lines.

It therefore becomes, I think, the necessary thing that the great engineering schools of the country should in large part contribute to the actual organization of the army in peace times, a substantial part, if not the major part, of the scientifically trained engineers which we will use in our peace-time army; and in our peace-time preparation for our defense, should aggression at any time in the future, again force us into defensive action.

I hope, therefore, that if the thing can be made concrete at all—and the whole problem of engineering education and its adaptation to military enterprise is too large to be compacted into a sentence or two—I hope that it will be assumed that one of the functions of colleges devoted to engineering training and technical training ought to be so to modify the curricula of their schools that the young men who have a special aptitude for those scientific things which are useful in military science, would have an opportunity to develop that aptitude. It would then be possible for them to bring their talent thus developed to the aid of their country, either as parts of the peace-time military establishment or, in a great emergency like this, as men already trained, fully armed as Jason's soldiers were when they sprang from the ground, in response to the emergency call of the country, ready to apply themselves to the grave national problems as we now face them.

My suggestions to you gentlemen—and I realize this is unspectacular and unemotional—are these three things, that all of the engineering and scientific genius and talent of the country ought now steadily and with the utmost of pressure be devoted to the study and solution of scientific problems presented by the war. You ought to further expedite the training of young men in engineering sciences for immediate use by the government in this great emergency. You ought also to look forward in the future to larger and larger contributions from your great engineering schools and colleges to the army estab-

lishment of the government and, collaterally, to so training the great body of your students that it will be very easy for them to turn from their civilized pursuits in time of emergency and render the maximum of assistance to the government if the emergency comes.

Nobody knows what the world is going to be like when this war is over. No imagination has yet been able, I think, even faintly to picture the sort of civilization which will exist in Europe after this fearful conflict is over. Nobody knows how long the conflict is going to last. Nobody knows as yet how many more bitter sacrifices the human race has to make and how much more of the ethical and social and industrial and scientific and spiritual gains of one hundred years of civilization are going to be sacrificed before a just and permanent peace can be established in the world. But we do know that when this war is over the rehabilitation of a stricken, if not paralyzed civilization is going to be a long-drawn-out and uphill task, and there will be need on every hand for trained minds, for trained and skilled bodies; that the day of the engineer will then be the big day. He must then be very truly the bridge between science and society. He must then be present in very great numbers to help to bring about the rehabilitation of industry, the reorganization of transportation facilities, the reconstruction upon an earth which has been swept by an all consuming conflagration—he must be there in great numbers to rebuild the world. So I think you ought to have as a very special object, the invitation, the urgent invitation to the young men of America to come into your technical schools and devote themselves to the various branches of engineering education, so that when this war is over the call will not be in vain to young men who have had the training and have learned the lessons necessary to enable them quickly and rapidly to play a part in that great reconstruction enterprise.

My own hope about this war of course is that the bitterness will not be indefinitely prolonged. My hope about it is that some day the sun will rise, and of course the fixed intention of

the American people is that when that peace does come, it shall be a permanent peace—a peace based upon such a just recognition of the rights of men that the pretensions of dynasties and houses and the prestige and contentions of autocracy will have all been swept into the waste basket of a forgotten age.

We have just emerged into the twentieth century, and it seems there are just a few "hang-over" impossibilities from the nineteenth century that will have to be eradicated before the plane of life will be possible of elevation; and when that peace does come, permanent because just, based on such arrangements that all nations will realize the wisdom and the humanity and the spiritual quality of a recognition of rights of others, as well as an assertion of one's own rights—when that time comes, I think America will have and shall have an opportunity to do a great service to those who are to come after us. And when the reconstruction of the world has taken place and a fairer and better civilization has been worked out, and aggression of the kind that we have been accustomed to in the past is a forgotten thing, and the human race puts its shoulders to the wheels of industry and begins to spread abroad over the whole mass of mankind these incalculably valuable discoveries of science and the application of them through the engineering professions, I can imagine that a new history of the world will be written. It will date, I think from this great war when men realized perhaps for the first time in any deep fundamental way that the wastage of conflict was an intolerable wastage; that the array of nations against nations rather than armies against armies is too vast a burden for mankind to bear, and that the real happiness of all men in the world depends upon the peaceful pursuits of those devices which science has discovered and engineering perfected to make available for the support of men in a world of great resources, that earth which we inhabit!

MILITARY ENGINEERING.

BY GENERAL WM. M. BLACK,

Chief of Engineers, U. S. Army.

I have not prepared any set speech for this afternoon. I was told some time ago that I was to be given the honor of speaking to you and was told of one or two things on which they desired me to give the army opinion, and perhaps I might start on them first.

One of the questions that come up to all educators now is, which is the more necessary, continuing the school course, or going to the front? I want to tell you how we in the army think of that and what we think of it. It may possibly help you.

As you know, the first class at West Point was graduated in April of this year, two months early. That really did not lose them any of the course, because the time lost from the Academy would have been devoted mainly to review work, so they were able to go into the service and get their diplomas with practically the same training as if we had held them there to graduate in June instead of April.

Due to a dearth of officers in our service, it was concluded advisable to take the second classmen and put them through an intensive course so as to graduate them in August. That does not mean the loss of the entire year, for the reason that ordinarily at the military academy from the middle of June until the first of September the time is taken up entirely in practical outside exercises. They are now given some of them plus a lot of theoretical work. Then the question came up whether it would be advisable to limit the course at West Point to two or three years in order to provide the supply of officers necessary year by year. That was given

extremely careful consideration in the War Department, considered first by the academic board at West Point and then afterwards referred to the various officials in the War Department, and practically all the graduates who were on duty there were consulted about the matter. After very careful consideration we came to the conclusion that inasmuch as the supply of officers that could be given by West Point is very small anyway, but a small drop in the bucket compared to the number we have to have, and further inasmuch as the advantage of West Point came from a finished product, formed by four years of severe labor and that that finished product had been, as it were, an example to the rest of the service, so that the man coming into the service from other sources had a sort of criterion to which to work in the way of military discipline, that it would be extremely inadvisable to lower that standard; that the good that would come to our country for the long future required that the four years' course should be kept up, and that men should not be graduated half educated, and although we are in the war of unprecedented magnitude when disciplined and trained men are urgently needed, we concluded to keep up the four years' course at West Point during this war, just as it was kept up during the Civil War, so as to provide the trained, finished product of the Academy for the army as the time went on.

I think that that need exists through all our educational institutions, that the trained technical man should be provided for the future. We all know that men who are eminent in their professions who never had the advantage of that early training, will themselves be the first to tell you that they have felt the disadvantage. Our country is going to live long after this war. We hope and believe that our form of government is the permanent one of the world. Today it is the oldest government in the world that is settled and fixed—I was going to say with the exception of Japan, but after all the Shogun has gone from Japan, and our government, our form of government, has remained where others have gone. I do not recall a single government which in its present shape

is as old as ours, and yet ours is called an experiment. But we believe, and believe truely that this experiment is a successful one. If that be so, it must be carried on with the same quality of men, the same quality of brains, as we have had in the past. This cataeylsm of war must not be allowed to disorganize our structure for all time, and one of the things we will need after the war, just as we needed it before the war, just as we are needing it today, will be trained young men to take the place of the older who go out.

So that I would think it a great mistake for the educational institutions of our country to shorten their courses or in any way to cease to provide this trained product, just as I think it a great mistake for our young men to leave these courses before they are trained, excepting those who may be strictly needed. We have enough men for our army without taking all the trained specialists, and particularly men in training and before they are trained specialists.

The engineers of our country responded most nobly to her call. The action taken by the engineering societies about a year ago has been productive of very great good, due to the fact that they were able to get incorporated in the law—I think it was May of last year—a provision for the engineer officers reserve corps. The engineer department was ahead of any other department in this preparation, in being ready to meet the call, excepting the Medical Department, which had also had the advantage of the same kind of reserve corps that we had. When we made our request of the engineers to come into active service they came forward in numbers greater than we can actually handle. It is a mistake for a trained man to go into the ranks with a musket. It is a waste of good material. How many of us will be needed we do not know, but do not let us waste this wonderful material that we have by putting a man, who is fitted to be a leader of men, fitted to do high service, to the performing of a service which does not require education or training, with the probability of his complete loss to the country.

So I think we can assure all our young men that the country

for the present has a supply of young graduates, men who have completed their school training at least sufficient for our needs. The training camps are over-full. In our own corps we have received a great many more applications than we can possibly take care of. There are more men now commissioned in the reserve corps than we can place in the regiments we are forming, and that despite the fact that in the regiments that we will form for the National Army, as it is called—I do not know how large it is, but taking the first call of five hundred thousand men—we will not be able to give more than two regular officers to each regiment. That will be just enough to guide the others.

So I think it would be very advisable indeed for the educational institutions of our country, the schools of technical training, to keep right on with their work. If any young man feels it is his duty to go out, let him go. It may become the duty, the increasing duty, for more of us to go. But in the meantime we can all of us serve by doing to our level best the duty that lies immediately before us, and be prepared for further calls when they shall come. So much for that subject.

I do not know that there is very much more that you want to hear from me. I want to tell you, however, one difficulty that we have had in filling our engineering corps itself. The number of graduates from the Military Academy has never been great enough to fill the ranks of officers of the regular service. I think the highest proportion of graduates we have ever had in the service at large was not over about forty-four per cent. Since the army has been increased, we are quite unable —to get enough men from West Point to fill the ranks of our corps, so that about four or five years ago the provision was made in the law that each year we could obtain from the graduates of technical colleges in civil life a certain number of officers, enough to fill out. As a matter of fact, we never have been able to obtain them. The fault has not been at all with the difficulty of the examination. The fault has been partly with the schools, but mainly with the young

men themselves. In civil life a young man gets a diploma as a civil engineer, and goes right into the employ of some large company, and quickly finds his level. I do not suppose over ten per cent., or fifteen per cent. at the very outside, of all the graduate engineers of the country ever rise beyond subordinate positions; so that a college, a technical school, can freely give a diploma to a man who has answered a certain number of questions and studied a certain number of books, although, as one of the faculty of one of our foremost engineering colleges told me, they know they graduate a number of men who never will be engineers. No particular harm is done the country. The training is good for them, but those men will not be advanced. In the corps of engineers we are differently placed because, due to things we need not discuss here now, it is absolutely essential in the army that promotion shall go more or less by seniority, partly because of our own form of government. We in the army are very much afraid indeed of having promotion made by selection. That sounds very curious. It sounds as though we were opposed to having a good man go forward. The trouble is, who will select them? In the past, selection has not been altogether happy. We found it better to take the men as they come along, especially if we can eliminate the men who are notoriously unfit, and in peace times we can get rid of them. The service is better off by letting men go up by age merely. There is less harm to the service.

In time of war it is different. In time of war a man has a chance to show his mettle, and he may show such commanding preëminence that he must be advanced; but in times of peace that can not be done. That being the case in the corps of engineers, you can see that each officer of the corps must be advanced through lower to higher duties until, when men come to the top of the corps, they have position and responsibilities which are held by but few men among the civil engineers of civil life. They have enormous responsibilities, and therefore we must be careful, in getting men into our corps, to get only, if possible, the kind of men who are capable

of advancing to that position and who are capable of going to these higher responsibilities, because we can not hold them still as you do in civil life. So, out of a class at West Point, all taking practically the same course, we do not want and would not want at all, more than, at the very outside, perhaps one fifth. We can not get as many as that. This last class that graduated had one hundred and forty members. Of that number we asked for twenty three for the engineers, and we were a little bit uncertain whether some of them were the best.

From the technical schools we want only the best. Unfortunately, except for the man who knows the army and who loves the service, there are no inducements for a good, bright able young engineer to go into the army at all. It is nothing but genteel poverty from beginning to end. It is the scraping of each penny, squeezing it hard, in order to get through; and so these young men from the colleges find they can do better for themselves in civil life, and it only once in a long time the young man who knows the service and knows the peculiar pleasure we have in being in it, the peculiar satisfaction that comes from living as we do, entirely for our work without anxiety for personal gain, who is willing to come to us, and the result is that I presume the great majority of the men who apply for examination are men whom you yourselves, if you were going to select associates, would probably reject. The result is they are rejected, and we get a very small proportion who pass.

I think that is one reason why we have been able to get so few men from civil life into our corps through these annual examinations. We want them, we need them. Today, as soon as all promotions for which there are vacancies are made, there will not be a single lieutenant in the corps of engineers; any man who gets a commission in the corps of engineers becomes a captain right at once. Of course, that is not as we would like to have it, but it only shows how difficult the situation is. We have just had an examination in June for which we have not yet heard the results. There

were many applicants and we hope we can get a number of good men from them; but in looking over the questions and in looking over the answers, as I wish all of you gentlemen could do, I realized, as I think you would all realize, there is something wrong with the teaching. When a man can graduate at a technical school and work five years on a railroad location and then can not make a little topographical map without any difficult features on it, he does not know topographical surveying very well.

Again, we have always in the Military Academy carefully paid a good deal of attention to descriptive geometry, and I find that is being dropped more and more from the ordinary courses. I think that is a great mistake, gentlemen. He is a very poor engineer and never will rise to a high position or do great things who can not visualize a problem before him, who can not see, before he has laid a stone or dug a single shovelful of earth, the completed work standing out. Is there any single study in the curricula of the schools which will aid that visualization as will descriptive geometry? So I would commend to you a little bit of thought about that, whether it is not wise to give a little more.

West Point is not a great engineering school. If you compare its curriculum with that of the Boston Institute of Technology or with those of a dozen other schools, you will find at once West Point should not turn out engineers; and yet it does. I think we can point to Goethals and think of a great many other men who are pretty fair engineers, as they go. Is there not something a little more than the mere acquisition of knowledge that should be had at the schools? West Point does not teach it concretely. The engineering course is quite short, but the mental training at West Point is very, very long, and very, very hard. West Point does teach those boys to concentrate themselves on whatever they have before them. It does teach them that the lesson of the day is the task of the day and the thing to be learned. It discourages very decidedly a man making side excursions into knowledge, no matter how important they may appear. The

first thing it asks is, "here is a certain task you are put upon to perform. That is your duty. Have you done your duty?" That is drilled into cadets from the time they enter until the time they leave. That is one thing.

Then another thing: If you will examine that curriculum of west Point carefully, you will find that it gives to anyone who has apprehended it, who has learned it thoroughly, the tools that will open the gates of any profession, and has given him a mind after that training that enables him to use those tools, and then the mere acquisition of knowledge afterwards is a very simple thing. Are the educational institutions of our country taking that view? Are not some of them trying to cram a whole lot of facts, so-called practical work, into men without giving them what is much more essential, training; that training of the mind which will make it a machine capable of coping with anthing, and with that devotion to duty, that idea of duty that makes the man feel that the thing that is put before him for the day is his task and no matter how alluring other things may be, no matter how unpleasant that task may be, how distasteful, yet that is the thing to be done and that must be done before anything else? I think those are the things West Point gives, and you know whether the other institutions follow.

In the engineer corps it became necessary last year to change our policy. At first when we started to obtain men from civil life we were groping around to see what we could do and we restricted the application for entrance into the corps to graduates of a few of the better known institutions of learning. We did not get material from them, as I have told you. Out of twenty-five or thirty candidates, only two or three passed. I know that out of a class of five that entered a year and a half ago, we had to send two out. There are only three left. You see we give a man, when he comes in, what we term a provisional appointment, which is a most wise provision of law. After a candidate gets a second lieutenancy, he can go right on up, but yet with that provisional appointment during his first two years, and if during that time he is found incapable

of handling men, incapable of getting the full grasp of the situation—it is not only a question of the mental examination, but a question of the man himself—then he is allowed to depart—in peace. Last year the policy was changed and candidates from practically all the schools of civil engineering of the country are admitted to the examinations. We want quality of man rather than quality of education, if the choice must be made.

I do not know that I have any other suggestions to make to you. If any of you have any questions you would like to ask, I shall be glad to answer them.

Someone said something about military engineering. Military engineering is one of the most simple things in the wide world, and it practically amounts to giving a man a lot of experience, so that if he is told to do a thing, he will take anything that there is around there—it does not make any difference whether it is the conventional thing or not—and do it. That is all there is to military engineering. Of course, there is a science of fortification, and it is most interesting. There is a science of war. Take that question of the science of fortifications, and trace it back through the early times, and you will see that it consists right along of certain fixed principles which were learned years and years—yes, centuries ago. As the weapons of war changed, and the missile weapons increased in power, the practice of fortification simply changed to meet the new conditions. The material was changed from wood to stone, and then to earth. You know they tried to go back to stone, but they had to give it up. Earth is the best.

So you can see a gradual growth all through, and it is a most interesting proposition. In the science of war, the principles have remained the same. The great soldiers of a thousand years ago should be the great leaders of to-day. It is simply the application of the principles that has changed slightly, not very much even in that. This war is being fought on three dimensions, where we had one before, and I am not sure they will not find the fourth before we get through with it. At any rate there is nothing specially new. The missiles

are the same, the means or instruments are the same—simply improved and, being improved, their application changed. So it is not so very difficult to learn to be a soldier, because after all, gentlemen, the profession of being a soldier or the fact of being a soldier is much more a mental and moral attribute than anything else—the willingness to subordinate one's will absolutely to the will of the person placed in authority over him, and then the willingness to accept responsibilities within the sphere assigned to one for action. That is the main thing in being a soldier, but it takes a great long time to get it, I can assure you.

F. B. Gilbreth: This talk, given apparently off-hand in an informal manner, I consider one of the most important speeches I ever heard in my life. I think that not only the small proportion of men who are going to be graduated as engineers should have the benefit of that talk, but the teachers of the boys below in the grade schools as well should have it. I would like to know if it would not be possible to have this society print that informal talk of General Black, and have it for distribution among our friends of education and our employers of labor, and the fathers and mothers who are sending their boys to school.

The President: It will be printed in the proceedings, you understand.

Mr. Gilbreth: It will be printed next fall some time, yes; but I mean immediately.

The President: I do not know just how long it will be before we can get this out.

T. U. Taylor: There are a great many engineering schools in the country, of which we are one, that have not military training at the present time. We are doing what we can in engineering strictly. I wish to ask General Black if he advises the incorporation of military drill or military science with our engineering work?

General Black: I must say I know of nothing that would help you more as educators than to have military discipline with your work. I wish you could be at West Point and see

the ease with which the instructors conduct a recitation. The young men march in there and take their places. The section leader reports all present, or as the case may be, and they seat themselves, and then they go up to the board, and the instructor has not anything at all to do except to find out what they know. The whole question of discipline, of keeping quiet or anything of that kind, is not present at all, and it is a mighty good thing for the boys as well.

On that question I would be glad to say something more. We have had a great many applications for officers to go to the schools, especially the engineering schools, for the purpose of instructing. Just at present, it is quite impossible for us to comply with those requests. The supply of officers is too limited. If this war continues, gentlemen, I am afraid there will be a very large supply coming back—it has been found so abroad—in men partly disabled. Just now we can do nothing. That applies to all our service because you want to get good men at these schools or you do not want anyone at all; but there will be a supply coming, we fear, from the front before very long. Then we will be able to do a little toward assisting in the education of these schools.

Dr. Taylor: Another question, please, General: We have been up against the proposition of making it optional or compulsory.

General Black: What do you do in your own family?

Dr. Taylor: Compulsory; but it does not always work. I wish to say that last spring, about two months before the session closed, we had this experience at the University of Texas; and that is the reason I am asking these questions. The faculty passed a resolution compelling every student of the university to take some form of military science. The girls had to take up the question of the food supply and study food problems. The boys had to take military drill unless physically disabled. We found this perhaps contrary to catalogue regulations, but we notified the prospective graduates that all of them must take it or not graduate. If somebody had re-

fused, I do not know how in the world we would have gotten away with it. But out of the whole body, not a man refused.

This was our experience, however, between compulsory service and optional service: The faculty organized a military company, and men as old as sixty-four years were out there drilling. Our own was optional and the boys' was compulsory. General Pershing, from San Antonio, sent over some army officers to drill us. One of those told me that those boys from the University of Texas who drilled got as much in one week as the ordinary rookie got in six weeks. He said he never saw boys take it up so eagerly. But here was the difference between the faculty and the student body: The students had to take it to get their degrees, and the faculty did not have to take it. I was in a student company by choice and in a faculty company by choice. I learned as much in one morning drilling together with the student companies who had to take it, as I learned in a whole week in the faculty company, because the members of the faculty simply would not go.

I wish to say another thing, that that word "compulsory" struck me as rather a harsh term in our American democracy, but our boys took to it like the proverbial duck to water. I think it is because they were eager and felt they were doing a service that was needed and had some punch to it.

F. W. McNair: I have a question I should like to put to General Black, if he cares to answer it. It occurs to me there are other gentlemen here who may be in exactly the same position I am in with regard to this particular question, and possibly General Black, if he chooses to answer my question, can be of help to other men here. Before putting the question, I desire to express my appreciation of his address, and not only of its material, but of the manner of its presentation. Possibly the highest compliment I can pay the General is to say that I think he would make an excellent engineering teacher.

General Black: I have been one, you know!

Dr. McNair: That explains it.

I am interested in a young man who is at present employed in a mine in South America. He is underground superin-

tendent of a mine producing some two million pounds of copper per month. The man is nearly, but not quite, twenty-eight years old. I had from him a letter recently saying his contract with the company will expire on the thirteenth day of August, and that the next day he will start for America to enlist in this war. He asked me how he can get in where his training and experience shall enable him to render the maximum service of which he is capable. Naturally I would suggest for him the corps of engineers, but I understand that he will be too late for the second series of training camps and that the only possible opening for him is in the engineers reserve corps. If I understood the General correctly a few moments ago, there are now more applications for this than can be handled. Am I correct, and what should this young man do?

General Black: Yes, you are correct. I would say your friend could serve his country best by increasing the world's output of copper?

W. M. Thornton: Suppose the man comes back and reports, and is drafted and sent to the trenches?

General Black: Gentlemen, England sent, under stress of circumstances, her entire trained army into Belgium. Then England went to work with a volunteer army and drained off all her young men, and when she came to try to raise a further army, she had not officer material. So she adopted the policy, as did France, of taking the troops at the front, observing them carefully, and every man who was in the ranks who showed the intelligence and qualities of leadership necessary, was picked out and sent to a special training school and trained; so that men who do get in as conscripts, if they are the right kind of men, will not remain with a musket over their shoulder very long. We propose to do something of the same sort with our troops. We will use these training camps that we have now and will officer our first army from them. Probably that will be continued in a certain measure, but after that it is proposed that the large number of vacancies that will occur in the commissioned ranks of our army shall be

filled from young men who have proved their worth in the very best school of military science known—that of actual war.

G. D. Boyd: I understood General Black, in answer to a question just asked, to intimate the young man could serve his country better by continuing to mine copper. That young man is just twenty-eight years of age. How can he avoid registration under this selective conscription law, and would it be proper for him to do so and continue in his present employment?

General Black: He can not avoid it, but he can register by mail. Even if he happens to be one of the conscripted men and is shown to be in a position where his services are producing war material and that he is very valuable in that position, you will find he would not be called upon to go into the trenches.

M. B. Robinson: I would like to make a motion in regard to Mr. Gilbreth's suggestion that this paper of General Black's be printed at once and distributed to the colleges. It seems to me it is right along the work that Dr. Godfrey was talking about this morning. We need that advice in the colleges now, because a great many of them are going to change their curricula and going to do this, that and the other; but it seems to me that is very sound, sane, and wise advice, and if we could have that distributed promptly, it would be of very great value. I therefore, Mr. President, move that this be done.

(Motion seconded, and unanimously carried.)

Prof. Robinson: I would like to make one other inquiry about this matter, Mr. President. The distribution that is contemplated of that paper is probably larger and more elaborate than this society can stand. How many institutions are represented here—over one hundred?

The President: Yes.

Prof. Robinson: Why not give the opportunity to every institution represented in this society to take a number of copies and pay for them? I think our university would like to send out about five thousand copies of General Black's address.

The President: I think that could be arranged with Secretary Bishop very readily.

Prof. Robinson: I think we should put out about a million copies of that address into the hands of the schoolboys of this country.

Mr. Gilbreth: Mr. President, in order that there may be no slip-up and in order that there may be no rules or regulations or treasurers' reports to interfere, I will say that I will arrange to underwrite it in case anything else falls down.

C. F. Harding: I wish to suggest that inasmuch as some of the questions which have been answered by General Black so very thoroughly are perhaps quite as important to the universities and colleges as the address itself, that I trust those will be included as well in the publication.

The President: That will undoubtedly be done.

General Black, what would be your idea of colleges, trade schools, etc., arranging to assist those who are crippled and disabled to get into lines of work where it will be possible for them to make a livelihood?

General Black: That would be a good work, of course, if that could be done, because we will have unfortunately many men brought back who will require that particular sort of service. Many of them, as you know, have been doing that kind of work in England and in France. They are getting up special schools for men who are blinded or men who are more or less crippled, teaching them how they can still be useful to the community. If the schools and colleges should undertake that work, it would undoubtedly be a work of the utmost importance to the welfare of the country.

F. H. Constant: I should like to ask General Black a question. Will the Government coöperate with colleges in encouraging the students to remain until the end of their course by exempting perhaps selected groups of students from conscription until they graduate?

General Black: I think I can answer that indirectly a little bit. We have had this officers reserve corps, you know, for considerably over a year, and we got a most gratifying num-

ber of applications to join the officers' reserve corps. Then on toward this spring came a lull. Then came up in Congress the question of the passage of a conscription act, and as it became increasingly evident that this conscription act would pass, an increasing number of anxious parents came to us to have their children join the reserve corps. I think you would have a larger attendance at your colleges of a class of material that you do not want than you could take care of if any such exemption were made.

F. L. Bishop: I would like to ask General Black one very concrete question. When we introduce military drill into institutions that have not had it, can there not some method be provided for securing guns? They can not be bought in this country as you know. The Government will not issue them, and we are up against it at the present time on that proposition.

General Black: Some firm at Philadelphia is turning out a gun that will not shoot, but in other respects it is altogether a gun, and at a very low price. At present it is quite impossible in our country to get the service rifle, and it is going to be impossible for a great many months yet. They simply are not here. I doubt whether it would be possible at all, for the call is to the front, and, gentlemen, we have not prepared and we are not prepared. If you only knew!

Dr. Taylor: General what is the name of that firm in Philadelphia?

General Black: I saw their advertisement in the *Army and Navy Journal*, but I can not remember it at this moment.

Dean Thornton: I was told there are three hundred thousand Krag-Jorgensen rifles that are in the arsenals of the Government which are not going to be used.

General Black: I do not think you will find any of them there. They had to be used. It is essential that the men at the front have but one kind of rifles, because of the ammunition supply; but there are large numbers of troops left in this country who can use them for all sorts of purposes, and the Krag-Jorgensen is a perfectly good gun as long as

we do not have to supply ammunition for it along with some other guns. Those are all in use today.

Dean Bishop: In connection with the engineers' reserve corps, it happens that in a group of fifteen technical men, nine have either received commissions or have been recommended for commissions, and if they should all be called, that department in which they have been employed would be pretty well depleted. I wonder if any provision could be made for taking up that question of too many members of faculties leaving for the service?

General Black: Yes. In the river and harbor works, a very large number of our assistant engineers desired to join the officers' reserve, and a number of them obtained commissions, but because of the need of the service right there, we do not call them out, and so far as the negineers' reserve is concerned, if any institution will let us know that this is the case, we will endeavor so far as possible not to bring about that state of depletion.

G. F. Swain: I move a rising vote of thanks to General Black for his very inspiring address.

THE ADVISORY FUNCTION: ITS PART IN WINNING THE WAR AND PREPARING FOR THE PERIOD FOLLOWING THE WAR.

BY HOLLIS GODFREY,

President of the Drexel Institute, and Member of the Advisory Commission of the Council of National Defense.

The engineering teacher has two functions. First, as consultant for the many engineering problems, and guardian of the knowledge of the schools, it is his part to keep abreast of the art of engineering and to encourage in his own practice, and in the practices of others, the best of the art of engineering. Second, as teacher it is his duty to carry the flame of learning to his students in his own branch in such a way as to keep them not only abreast of the best of the art, but convinced as we older members of the profession have long been convinced, that there is no profession greater, and no profession more necessary than that which we represent.

Never was the task of the teacher and engineer more important than today, nor has there ever been a period when the fundamental beliefs of the profession are in greater need of definition in face of the fact that this war has thrown upon the engineers of the United States the responsibility unrivaled in consequence and a burden, the extent of which we hardly realize.

If there are two lessons this war has brought beyond all others, they are, first, the necessity of having applied science based upon a sound national belief, and secondly, the necessity of sending out practitioners of the art who shall understand the needs of the art and the need of the highest kind of engineering and education. It is for the promotion of engineering and for the advancement of education that I am

endeavoring today to place before you a summation of the fundamental principles which are involved in the engineering profession as it comes forward to meet the needs and solve the problems of the great war for liberty.

On August 29, 1916, by the passage of the bill creating the Council of National Defense with the Advisory Commission, the Congress of the United States created what was practically the first purely advisory function as opposed to executive or constructive positions ever existing in our government. In the words of the President given at the time of the appointment of the seven commissioners of the Advisory Commission, "this means the entrance of the engineer and business man, etc." In the division of work among the commissioners, the section of Engineering and Education was given to me, making it encumbent on me as the first holder of this office to do two things.

On August 29, 1916, by the passage of the bill establishing the Council of National Defense with the Advisory Commission, the Congress of the United States created what was practically the first purely advisory function as opposed to executive or administrative positions ever existing in our government. The appointment of the seven commissioners of the Advisory Commission meant that the engineer and the business man had been called into public life. Upon taking up the duties belonging to the section of engineering and education, it was necessary for the first encumbent of this office to do three things.

First: to answer all emergency questions which might arise, to give advice and council to the government and also to others so far as possible, and to coördinate existing forces of engineering and education.

Second: to establish a fundamental method for the work of the consulting engineer concerned with such varied and complex problems. This method must be applicable to all types of industry and shall accord strictly with the laws of natural science. It should be evident that no matter what the exigencies of war, no office can be successfully carried on without

a comprehensive policy whose work is based upon a fundamental method.

Third: therefore, to formulate a comprehensive and continuous policy for the office which was held, for the first time, by a consulting engineer.

What are the advisory duties of a consulting engineer, a member of the Advisory Commission of the Council of National Defense of the United States? The answer of this question to all intents and purposes, embraces the task which has been laid upon the member of the Advisory Commission of the Council of National Defense as is indicated by the definition of the task as given by the wording of the law, and from the minutes of the Council and Commission.

It was a large part of the work then, to develop, as this third part of the duties of office, a comprehensive and continuous policy provided the emergency needs of the nation could be fully met as they have been. Such a definition of policy as might serve as a basis for growth and constructive criticism has been drawn up, based on the assistance and constructive criticism from members of the executive and legislative branches of government, from the engineering and educational profession, and from leaders in manufacturing.

The paper following therefore, may, fairly be said to be a composite of the action of many distinguished minds which have considered the problem, at the author's request. It is interesting to note that no constructive criticism received has been omitted from this statement, and that action has been taken on all destructive criticism if any basis were given for such criticism. Constructive criticism is the life of both scholarly and industrial advance, and no man devoted to science can receive too much of it. The desire to obtain such constructive criticism, is the primary purpose of this publication.

So great a crisis is now before us that any one man or group of men must have the greatest difficulty in formulating a comprehensive and continuous policy which can be truly effective and permanent. It is for that reason that constructive sug-

gestions are asked for—suggestions that will make for the betterment of any work, phrase, or principle included in this paper.

This publication, then, must be considered as a tentative draft of a policy submitted to you for such criticism, for it is only by the publication of a policy and discussion as to the effects of such policy that we can come to the end which we all desire—the winning of this war and the preservation of liberty and democracy.

On one of the top shelves of my library rests my great-grandfather's "Rasselas," bought by him in London in 1817, and illustrated with clear woodcuts showing the young Rasselas at different stages of his philosophical path. Now and then I turn the old pages to read again the fundamental truths of that philosopher and particularly that paragraph in which Dr. Samuel Johnson gives his concept of a cosmic philosophy. He says: "A philosopher, furnished with wings, and hovering in the sky, would see the earth and all its inhabitants rolling beneath him, and presenting to him successively, by its diurnal motion, all the countries within the same parallel. How must it amuse the pendent spectator to see the moving scene of land and ocean, cities and deserts! To survey with equal serenity, the marts of trade and the fields of battle; mountains infested by barbarians, and fruitful regions gladdened by plenty and lulled by peace! How easily would he then trace the Nile through all his passage, pass over to distant regions, and examine the face of nature from one extremity of the earth to the other!"

The great Dr. Johnson conceived in these words the position of a philosopher observing the whole earth and studying it as a single problem. His philosopher, it is true, fell into the lake because his wings were not properly constructed,—an inevitable conclusion to any attempt to overcome a great obstacle when technical theory is not checked by actual practice. In short, he was not a pragmatic philosopher, and he found that his special theory would not work when really put to the actual test. As we may express it to-day, he failed because his tech-

nical theory was not checked up on a thorough knowledge of shop practice.

I am constrained, in my study of Rasselas under this quotation, to find a parallel in the case of the philosopher, with some of the difficulties which exist in the Government in its philosophy and in its engineering practice. To win the war, the Government must recognize a philosophy of work,—a cosmic philosophy, if you will,—which, in its viewpoint, will embrace "the marts of trade and the fields of battle,"—and see "the face of nature from one extremity of the earth to the other." More than this, to be successful, and not to follow the philosopher of Dr. Johnson in his fall into the lake, the means by which the cosmic viewpoint is obtained, and the tools and methods by which it may be hoped will produce the inevitable ends to be gained by such a philosophy—all must be tested out by the shop practice of the times. In this regard, as the member of the Advisory Commission of the Council of National Defense especially charged with problems of engineering, I am going to speak of the consulting engineer, of his relation to the government, and of his place in making effective in time of war governmental organization and machinery.

In order to clarify the whole matter, I am asking you to turn back, for a moment, and review the construction of the Council of National Defense, a body created to "coördinate the industries and resources for the national security and welfare." The Council of National Defense consists of the Secretaries of War, Navy, Interior, Agriculture, Commerce and Labor. Of the Advisory Commission, on which I have the honor to serve, representing Engineering and Education, those two joint sectors brought together in this Society for the Promotion of engineering education, it is my part to say a word, especially as the duties of the seven members of the Advisory Commission have been stated by the Council as those of "the formulation of plans and giving advice and council."

It would be difficult indeed to get a more direct statement of the functions of a consulting engineer than is given by these very words,—"the formulation of plans and the giving of ad-

vice and counsel.'' What is the task of the consulting engineer along these lines? Primarily, so far as the formulation of plans is concerned, the consulting engineer has long served corporations in the capacity of an adviser on matters of importance; it has been his task to obtain, to order, to select, and to define physical factors in such a way, that they may serve as the basis of wise decisions in respect to future policies. Whether or not labor should form a part of the consulting engineer's task in the laying out of plans, is still somewhat a matter of opinion, but, in this discussion, I am limiting myself to the physical problems, because of my conviction that, in any difference of opinion between capital and labor, the best common ground on which they may come together, is, found in the elimination of physical obstacles to production.

Corporations, in their recognition of the value of the consulting or advisory factor, are far more long-sighted than governments. They see the value of reasoning from the known to the unknown, and of using ordered, tested, and selected facts as the bases of policies and decisions.

Democracies, on the other hand, from their governmental side, are peculiarly unwilling, in general, to face the facts as a consulting engineer is obliged to face them. Their decisions are, as a result, often empirical, based upon opportunism or upon pure guess work, instead of upon facts selected, ordered, and arranged. Perhaps this reluctance arises from an inherited fear to trust men in an engineering capacity, just as they fear to trust them in a political capacity, as evinced by the long series of constitutional checks and balances existing in the state.

One of the greatest of American statesmen once said to me: ''There is no greater peril to the democracy than the fact that comparatively small organized minorities are able to secure the enactment of laws profoundly affecting large unorganized majorities, based upon theories which are often unsound rather than upon organized and tested facts.'' Later, one of our greatest diplomats expressed a corresponding thought in these words: '' My greatest fear for the preservation

and advancement of the republic is that not even the present crises and the stress of war will serve to give to the Government a comprehensive and continuing policy based on organized and tested fact rather than on theory. Britain is far more likely than we are to persist in holding to a comprehensive and continuing programme based on the experience of the war. Many of her policies to-day go back to the time of Pitt and have been steadily advancing since that day, and I should expect to see in Britain a hundred years from now, policies advancing which were founded in the years of this great war. But with us policies are disorganized. With every change of administration, even where the same party remains in power the need for a comprehensive and continuous policy based on organized and tested fact is forgotten.

It is on the work of the consulting engineer in obtaining organized and tested facts as a basis for comprehensive and continuing policies, that I am to speak to you today.

War is a stimulus to such policies as cannot long be resisted. Of all the great sectors of man's activity, war appears first in the mental, breaking down prejudices and traditions, instilling patriotism, and clarifying disordered concepts. Under conditions of war, there is a tendency to banish theoretical concepts by cold facts, and to test everything by its practicability. The engineer is always basing his decisions upon *what is, what ought to be*, and *what can be*. He brings together the essential knowledge of a situation, carefully separates the essential from the non-essential, selects from that essential information the best, and builds up *what ought to be*. He studies those conditions which limit him, endeavors to find substitute factors when existing factors are ineffective or insufficient, and determines the relation of *what ought to be* to *what can be*. But the consulting engineer holds fast to one principle. He is convinced that it costs less to make mistakes in the laboratory than in the shop. The engineer is engaged, in the words of the old British Institution of Civil Engineers, "in directing the forces of nature to the use of man." In this war, all the technical knowledge and shop practice of the engineer should be turned

to one end to strengthen production and quality and to diminish the time of deliveries: *in brief to produce results.*

Let us stop for a moment to consider what are the powers of the engineer. The great task before him, in any great business, is to determine the answers to those sweeping and embracing questions of *what is, what ought to be,* and *what can be.* A man, to attack such a problem, must have well defined capacities and powers. In this section of the paper, I wish to discuss the powers which the consulting engineer has at hand to determine the answers to those three questions, as he examines not merely the whole of one business, but the whole of a nation's business allied with the best part of a world, in the great struggle for liberty. The consulting engineer is able to make sound judgments and to increase the opportunity of right decisions markedly more than other men, because he is able to reason from the known to the unknown. He has the knowledge based upon toilsome experiment, upon the thought of many decades, upon the fundamental laws of physics, chemistry, and biology, and of the applied sciences which have been developed from them—civil, mechanical, electrical, and mining engineering and the branches of engineering derived from these. It is in his knowledge of the sources of physical knowledge, not merely examined as Dr. Johnson's philosopher examined them, but tested out in the laboratory as well as in the shop, that first we find the real basis of the engineer's power. In short, it is the duty of the consulting engineer to provide the best of the art, and to indicate where research is needed when existing knowledge is insufficient for working out the necessary details of a plan, and to secure sufficient foundation for a policy.

Of what does that best of the art consist? First, it consists of acquaintance with written knowledge. To the layman, it sometimes seems incredible that a hundred books may have been written by men studying a single detail of mechanic arts. From such ignorance comes the painful futility of men endeavoring to do over again tasks which have been proved impossible again and again in the years gone by. There is noth-

ing in which Germany has excelled more than in her habit of saving time by using the knowledge already accumulated. She has conserved the recorded facts in pure and applied science, and has made them available for the trained and experienced mind, which can select what is of value in that written knowledge, coördinate it, and make it effective.

But that is only one of the two parts of the best of the art. The other part is that which is held in the minds of men, and which is not in recorded knowledge, namely accumulated experience. At any period, a very great part of the knowledge of any art or any science, pure or applied, is in the minds of the men who are practising that art or that science. Publication comes slowly to most of us, and much of the best of any art always remains unpublished in the minds of those practising wholly. The consulting engineer is the true pragmatic philosopher, unwilling to base his judgment alone on the knowledge of the present day, as it exists in books and in the minds of men, but forever comparing it to that which is in his mind, and that which has occured in his experience.

Constantly answering by unequivocal tests the question "will it work," the engineer, so long accustomed to analysis and to classification, uses to a remarkable degree the mental processes which underlie organization and classification. He differs in his mental reactions from the empirical scientist. He differs, again, from the political economist in so far as he is always dealing with both the abstract and the concrete. His problem is to solve a difficulty which stands in the way of man's actual advancement in the practical world. From these facts, then, it is apparent that he is equipped mentally by training and experience to think from the known to the unknown, and to use his past experience in solving present difficulties.

All engineering problems are complex. They are built up of many different branches of knowledge, and when all the written and unwritten knowledge has been selected, and the best of that brought to bear upon the question, there yet remains the necessity of coördinating all that knowledge and

bringing it to bear upon the point at issue. That is, perhaps, the highest task that the consulting engineer can do. Nor is it possible for any man other than a consulting engineer to do this. You cannot turn to a layman and say, "Here is a brief which you are to argue before the Supreme Court next Thursday and here are the references,"—and expect a successful case. You cannot turn to a grocer's boy and say, "Here are the instruments. Operate for appendicitis next Tuesday,"—and expect a successful operation. It is no more possible to assume that a lawyer, or a clerk can use the tools of pure and applied science, select the essential parts of the written record of science, bring together, translate, and make effective, that knowledge which is in the minds of the trained and experienced engineer, than to expect marvels of operative skill of the butcher boy. Only when the fact is recognized by any nation will it be possible to obtain production, quality, and deliveries,—to obtain the maximum production of the right kind in the minimum of time, wasting no minute of time and no dollar of money. No waste seems more appalling to the consulting engineer than that which arises from the doing over again of something which once has been done well, or the making of important decisions by the hit or miss method when pure and applied science have already defined the correct procedure.

There is one other factor at work which deserves a paragraph by itself. It must be remembered that the concept of selective values marks the highest point of education,—the power to choose the essential from the non-essential, the power to see clearly which of two courses will produce the best result. That power the great lawyer has in his own profession and the skillful man of medicine uses in his diagnosis. We may well assume for our own great profession of engineering an equal right of selection; and we may, therefore, insist that no uninformed layman has a right to set his judgment against ours when a professional question is at issue. It is appalling that the ignorance of laymen reaches the point where they attempt to lay down laws which concern the engineering profession without knowledge of engineering principles. As we

know, any layman may state a theory, but let him once try to put it into practise without knowledge, and the whole of the structure which he attempts to build will fall into ruins. Man-made law, unless based on nature's laws, will always fail. It is at this point that I beg to put forward the word that, at the present crisis, it is most necessary that the engineer convince the economist that he must do what the engineer is always willing to do—submit his theory to the test of fact. The engineer is always a pragmatic philosopher, but too many economists still refuse that test.

I have discussed the question of the task of the engineer in bringing together, as the basis of the formulation of plans, the best of the art. There is, in reality, quite apart from this in one sense, and yet closely allied to it, a second function, and a precedent one in the point of sequence—the definition of the question to be asked. Even in small enterprises, the problems to be attacked are complex to a great degree. As any business increases, the complexities increase, not directly but in multiple ratios. The problem which is before my sector, for example, considering the entire United States as one business engaged in pouring all the material to the line of war,—the greatest problem of assembly since time began,—is one which cannot be solved except by the scientific processes of analysis, selection, and synthesis, which make each part of the problem tractable or usable. Any specific problem involved in this greatest of all problems must be defined in a fashion conforming to this. The necessity for exact definition of a problem is too much forgotten today.

Before a substance can be tested in the laboratory, it must be a substance which can be handled by the instruments of the laboratory. The consulting engineer is ever working in the laboratory of the mind, and in the laboratories of science. The need of making sharp boundaries for a problem, of separating a given problem into parts that can be solved by themselves and yet with relation to the other parts which make the whole, is seldom considered by the layman; yet every professional man who has had to deal with complex problems

of this sort recognizes the many facts involved. A lawyer who is endeavoring to defend a company, a doctor who is struggling with a mixed infection, both know that the first thing to do is to analyze the problem into its parts, to sort out the parts which can be coördinated, and then to coördinate them. It is impossible to solve an uncoördinated problem; yet that is what governments are trying to do all over the world today. They strike at random, and sometimes succeed, but more often fail. No greater lesson of the need for coördination and for use of the principles of analysis and of synthesis ever existed than now; and to meet this need great advances have been made. But until the world is educated to the prime necessity for the action of the trained and experienced mind upon the problem, true success will not come, nor will we be ready for that great period which will follow the war,—a period in which some disorganization will be inevitable and the necessity for order, selection, and coördination, great.

To summarize, then, there are two great functions of the consulting engineer in the work of the organization of the nation. First, he must define and order the problem so that the known and unknown factors may be separated and so ordered that the unknown may be solved by the aid of the known, and so analyzed that it may be solved effectively. Second, on the basis of his own training and experience, he must bring the best of written knowledge and unrecorded knowledge in the minds of men, to bear upon the problem. The relation of these functions of the engineer to the other great functions of the government may become clearer in the light of the following paragraphs.

Every business which is effectively organized comprises three separate parts: the purchasing division, the operating division, and the selling division. The consulting function in a properly organized business acts on all three of these divisions. Governments alone organize behind the immediate line of war and navy in but two of these parts—purchasing and operating. In most cases, indeed, the operating department goes on entirely separately from the function of purchasing,

because governments do not make the goods they buy. It is this very fact—that governments do not make the goods they buy—which gives rise to one of the most serious difficulties in any democracy. Our government, for example, has never been put to the sharp test of competition. It has never had to consider, sufficiently, the way in which things are made. It has never been thrown against that major problem of the war, —the obtaining of a maximum of production of the right kind in a minimum of time. The government buyers have simply bought a collar, a gun, a dish; and had them delivered the next day or some other day. They have never really visualized the long processes which go on before the finished article is ready for delivery to them. As a result, not only the difficulties but even the language of the engineer and manufacturer is little known to them, and they do not see the most essential points of production. They see production only as they stand and buy the goods. They do not see it in the manufactory. Production, to them, is measured in terms of a requisition.

One of the great tasks of the consulting engineer in the present war is to make the governmental agencies really appreciate the slow processes of production, and to aid them to form their plans accordingly. Until that is done, the general capacity of the engineering profession to shorten time of deliveries, to get more and more effective qualities, and to increase production, will be insufficient; for to obtain full effectiveness it is necessary to have the hearty and comprehending coöperation of those who order. The prime function of the engineer is to keep at full flow the river of production. He has nothing to do immediately with the determination of governmental prices or with the actual giving of governmental orders. Nothing really matters except the getting of the material to the men at the front,—the procuring of food, clothing, and shells for those who are standing between us and destruction. There must be a mighty river of production flowing to those men who are fighting the battles of the country. How can we

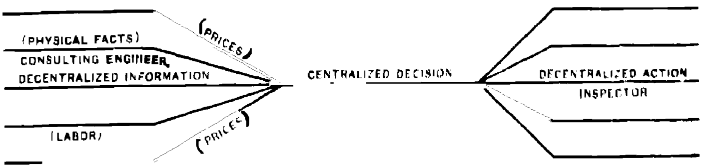
make that river broadest and deepest? There are just two ways which come first and foremost to us in the practice of our profession. We must make these two great powers, the determination of the best of the art, and the definition and classification of the problem, contribute to the removal of the limiting factors, and to the proper substitution of strong factors for weak.

Recall for a moment, that any industry may be divided into three great sectors,—the bringing in of raw materials, the turning of raw materials into finished products, and the sending of the finished products to the consumer. Consider the essential work of the consulting engineer in the determination of limiting factors. In an order of a thousand parts, perhaps a certain large number of them does not come in because not enough of the raw materials arrived; a second lot may be limited by the lack of machines or the breaking down of machines; and a third lot may not arrive because of the lack of cars to get the material to the consumer. So, out of your broad river of a thousand at the beginning, perhaps a hundred and fifty trickle in at the end. It is in the treatment of the factors which limit the quality and quantity of necessary supplies, that comes the work of the engineer. The raw materials must be sufficient in quantity and right in quality; the machines must be complete and running; the cars must be of the right size, and they must be sufficient in number. It is a case of qualitative and quantitative analysis and of qualitative and quantitative synthesis.

In conclusion, let me repeat that the task of the consulting engineer is the application, within the shortest possible time, of the recorded and unrecorded work of the most effective minds of the nation to each problem; the determination and definition of the problem; the making and defining of the bases for decisions; the bringing together, in the most effective form, of knowledge that has proved that it will work in the shop; and lastly, the application of the principal that technical theories must be worked out through laboratory and shop practice. In the end, the consulting engineer exists to bring order

into industry wherever chaos exists and to organize a disorganized nation for the most effective conduct of a world war.

Advisory Function | **Function of Administrative Decision of Policy** | **Function of Administrative Action**



THE GOVERNMENT'S NEED OF MEN.

BY GEORGE OTIS SMITH,

Director, U. S. Geological Survey.

I understand that I am recognized for a few seconds to make an appeal to you for help. Since early in March, the United States Geological Survey has been under orders of the War Department for military surveys. Our topographers have been doing that work where and how the General Staff has asked to have it done. The result is that our men are all engaged on War Department work, and we need more men.

About one hundred of our men have been commissioned as reserve officers of the Engineer Corps, and forty-five of them have been called to active duty and ordered by the Secretary of War to report to the Geological Survey to carry on these military surveys. So we have a combination of the military and the civil organizations, and we trust that we are doing effective work under such a coöperative system.

We need more men for this reason: There is more work in this country to be done than we have men to do at the present time, and we are also having our men called for service on the other side of the Atlantic. Fourteen of our men are soon to leave for active duty in France on special service. To meet this deficiency we are starting a summer school for topographical engineers, and we need to have candidates present themselves for intensive training, only a few weeks of intensive training, and then they will be put into the field along the Atlantic Coast or down on the Mexican border or on the Pacific Coast and work into our organization in that method. They need to be men with some civil engineering training. We have all of the applicants that we need for positions as rodmen and recorders, but we need instrument men.

If there are, among your recent graduates or among your undergraduates, men of the type that wish to become topographical engineers or wish to serve their country in this way, now is their opportunity to do some effective work just where it is most needed. Possibly General Black, under whom we are working, and in coöperation with whom we are working, may have indicated the country's need of this type of work. I feel that the need of men of this type to go with our army in France will become greater and greater as the time passes, and so we make this appeal. We are organizing this summer school, taking practically every applicant of the right type that comes to us, and as soon as the man is sufficiently trained putting him right into the field; and in the course of six months he may be available for examination and entrance into the engineer corps, the Reserve Officers' Corps of Engineers; and thus he may have the opportunity to choose between continued work in this country or service abroad.

We feel that we are very much in need of men. If each one of you gentlemen will get us in touch with one or more candidates, so far as topographical mapping is concerned, the country is safe.

I have just a few copies of a circular letter which was prepared to send out to such candidates, and I will leave these here, and any of you may get them. It is not a matter that we can publish abroad, because these are select men that we are asking to come into our service, men who have come not for the sake of the seventy-five or one hundred dollars a month, which is a small entrance salary for engineers in these times, but men who, from love of the work or for patriotic reasons, are willing to take part of their compensation in that kind of currency.

PRESIDENTIAL ADDRESS.
OUR PATRIOTIC DUTY.

BY GEORGE R. CHATBURN.

Professor and Head, Department of Applied Mechanics and Machine Design, University of Nebraska. President of the Society for the Promotion of Engineering Education.

No one regrets more than the officers of the Society that the exigencies of the times demanded a change in the general order of business this year. In fact we had practically finished our preparations for the meeting at Evanston prior to the declaration of war. Arrangements for the housing and caring for the members were well under way in charge of Director Hayford and a local committee. The general character of the program had been outlined. The Society committees during the past year have been hard at work and several would have made final reports. Dr. Mann's great work and the discussion thereon would have consumed at least two half day periods. Therefore the officers regret that such valuable work had to be put over until some future meeting.

There came to us many requests for an abandonment of the meeting altogether this year. After due consideration the matter was put to a vote of the Council. This resulted overwhelmingly in favor of a changed program, one pertaining to the proper relations of the technical schools to the government during the present crisis. The discussions upon varying phases of this subject during the past two days you have heard, and these, I doubt not, will prove beneficial to the technical schools and they in turn will react favorably to the government.

We would like to have retained the meeting in the middle west, not only because that region gave birth to the Society

itself and it would be fitting to hold the twenty-fifth annual meeting there, but because it has rightly been the policy to pass the benefits of our Society around among the several sections of the country. However, here again the exigencies of the times demanded that the meeting be held in proximity to those who were working out the measures for the successful prosecution of the war. We could not expect them to leave their work for two or three days, whereas if we came to Washington we might hope for an hour or two of the time of several persons in authority covering many branches of governmental service.

The Public Schools and Patriotism.

In the language of ex-President Cleveland, "a condition confronts us, not a theory." It is the duty of every citizen of the United States to show his loyalty and patriotism by deeds as well as words. Following the flag implies more than a display on the radiator of an automobile. Every person should "do his bit." This includes every honest organization, public and private. Our public schools have in the past inculcated patriotism in the rising generation. That these lessons have had their effect is evident now that many young men with teutonic names are rallying to our flag, are at the present time working hard not only with native sons but with the sons and grandsons of American Revolutionary families.

Herein has gone astray one of the guesses of the enemy, that our teutonic citizens with their children would prove more loyal to the "fatherland" than to democratic America. The lessons of patriotism the children brought home from the school were communicated to their parents and penetrated deep, so that only a moiety of our foreign born element may be classed as enemies. Thus have the public schools in this great melting pot of the world been the conservators of liberty. In them we learned to hate autocracy and subjection and to love democracy and freedom. In my boyhood days no country was so generally hated by the school children

as England. We had read in the Declaration of Independence that kingship had in many ways tyrannized over the colonies, and we rejoiced when in our school histories we came to a battle which was in any way favorable to the Americans and unfavorable to the British. We hated them all the more when we learned they had employed the bloodthirsty propensities of the Hessians, hired butchers from Germany. How delighted we were when we learned of the defeat of these Hessians by Washington at Trenton. As his victory put new life into the soldiers and kindled the fires of patriotism among the discouraged American citizens, so reading the stories of such acts sent the red blood coursing through the veins of the little soldiers of the school room, building them into patriotic citizens of a national republic.

Liberty the Birthright of our Country.

Our country has from its very inception been on the side of liberty. The voices of liberty loving colonies thundered in their assemblies; they denounced taxation without representation; they refused to use taxed goods; they declared themselves independent of foreign rule; they armed to protect what they considered the rights of free man; they resisted invasion and opened war for independence at Lexington; they went barefoot and hungry through the black hour at Valley Forge; and they emerged in the glorious dawn at Yorktown. Hence came forth a nation having liberty for its watchword.

Almost immediately the new and struggling nation helped to clear the seas of Barbary pirates, and soon again the freedom of the ocean was strenuously maintained. The principle of personal liberty, the right of any man to ally himself with any nation through the act of naturalization and thereafter be not subject to impressment by the mother country, was thoroughly threshed out in the war of 1812. The shackles fell from millions of slaves at the close of our great civil war. And it has been no uncommon thing for the United States to

help in various ways the peoples of smaller countries struggling for liberty.

The state of mind of the American people from the very beginning, therefore, has ever been for freedom: freedom of person, freedom of thought, freedom of speech. And now, when a great and powerful nation has by coercion allied itself to several other nations and forced a cataclysm of brutal savage war upon the world, for the purely selfish reason of securing "a place in the sun"; has contrary to the principles of international law overrun weaker nations in order to strike down a democratic ideal; has committed atrocities more brutal, more damnable, more hellish than the world ever before witnessed; has endeavored to dictate to us when, where and how we shall sail our vessels on the high seas; has without a blush of shame used our own capital while our guest as a base for treachery and underhanded conspiracy against us; when, after long waiting and patient forbearance, all peaceful means seem to have failed and our nation has once more taken up the sword in defense of freedom and justice, it is but right and proper that every resource of this nation should be mobilized that democracy, personal liberty and justice may be perpetuated.

Autocracy or Democracy.

Two antagonistic ideas are fighting for supremacy. Shall autocracy or democracy rule? Our President and Congress saw clearly that should the votaries of autocracy, the Hohenzollerns, and Hapsburgs and their satellites, win against England, France and their allies, the United States would be compelled to fight alone for its existence. The declaration of war was inevitable. The United States, the oldest democracy and the greatest champion of the democratic form of government, was to be the last enemy of absolutism to be conquered. The fight is not new; it has been going on since before the signing of the Declaration of Independence. The Hohenzollerns are the last important ardent supporters of the "divine right of kings." For years they have been preparing

for the coup which was to revivify that principle. Bismarck, who was nurtured in that state of mind formulated by Frederick the Great and carefully cultivated by his successors, the aggrandizement of Prussia, concretely stated in the national song by the phrase, "Deutschland über alles, über alles in der welt," had this in mind when, some fifty years ago while our nation was humanely setting free a race of slaves, he was binding together with bonds of iron under one autocratic control the principalities of Germany. He and those who succeeded him constantly had in mind the Prussianizing of the world just as they had Prussianized the small neighboring states. They trumped up excuses to use force where no apparent reason existed to compel the principalities to come under their sway. They stole Alsace and Lorraine and collected without mercy a bankrupting indemnity from weakened France. They saved this indemnity and added to it all possible resources to turn toward that day when the serpent of autocracy should consider it propitious to strike its deadly fangs into the heart of democracy. This is why when an excuse came through the pistol shot of a mentally deranged Serbian student, Germany declared war against Russia but turned right about face in the opposite direction and with her diabolically efficient army immediately overran unoffending Belgium and struck deeply and hard at Democratic France. This is why now she is not only willing but anxious to conclude a separate peace with the very country which she claims started the war; a peace without indemnity, loss of territory or punishment to that country, but at the same time holds out to her deluded tax-burdened starving citizens the plea that the great American democratic nation will in the end have to pay the entire war expense.

German Culture Disseminated.

But you may say, had not Germany done much for humanity? had she not become a leader in education, in science, in industry? were not her methods of government especially effi-

cient? We admit that such was the case, and had Germany been content with promulgating the arts of peace her influence would soon have been world wide, her "place in the sun" was all but gained. It had come to the point that hardly could one hold a professorship in an American university without a degree from Germany. German culture was being disseminated at a very rapid pace throughout the civilized world. The school master was doing for Germany what all the Krupps in the realm of satan himself will be unable to do. But now, after the grim spectacle of what German kultur really is, there is bound to be a reaction. German ideals will no longer be our ideals, German thought will no longer be our thought; conscience and moral ethics will supplant mere efficiency and greed, and the spirit of liberty, of action and thought, of justice and humanity to all, will once more permeate our schools.

There is Something for Technical Schools to Do.

Nearly ten millions of our young men in the very prime of manhood have been registered for potential service, and from these will soon be selected an army who go as a sacrifice that the rest of us may live in freedom. Now, my contention is, that it is not fair to these young men to ask them to work and sweat like slaves; to suffer agonies on the battle field, to eke out miserable existences, maimed and crippled, through future years; and very many of them to offer up life itself, that we may sit in smug contentment at home. Of course we have invested some of our savings in Liberty Bonds, we may even have donated a moiety to the Red Cross and the Y. M. C. A., that is not enough. After the discussions of the past two days it is not necessary for me here to review in detail what the schools may do. Preparedness, the husbanding and conserving of all our resources in men and materials, is an absolute necessity. The farms and industries are rapidly being mobilized. The fact that technically trained men are being searched out by the government proves the great need of such

persons. Engineering, chemistry and agriculture are assuming leading places. The farms are being called into their highest state of cultivation to supply foodstuffs. Manufacturing chemists are busy making explosives, medicines, antiseptics and industrial chemicals. The engineer must devise means of transporting the raw materials to the mills and factories, and from them in turn to the place of use. Tools, machinery and equipment must be supplied with the same certainty, regularity and constancy as guns and shells. Not only are engineers needed here at home but on the field of battle. There are military roads to build, rivers and gullies to bridge, field fortifications and trenches to lay out and construct, siege equipment to set and operate, water supply and sanitation to provide, communication by telephone, telegraph, wireless and aircraft to maintain, and hundreds of other things to look after. These must be done in a quick and efficient manner, requiring the best efforts of thorough training and highest intelligence. In war time, also, demolition is quite as necessary as construction, and requires a high degree of skill to do it effectively so that it will retard the progress of the enemy and at the same time do as little damage as possible to the future occupation and use of the country.

Ten million men have registered for conscription. It is estimated that of these not to exceed 70,000 are technically trained. The supply of trained men is hardly sufficient in times of peace, and certain in periods of war, when many are taken for unusual activities, there is greater need. Should the war continue two or more years the supply can only be maintained by the utmost efforts of the engineering and technical colleges. The number of technical graduates each year is not in excess of 7,000. Just how many of the 70,000 within the prescribed age of conscription will be taken into the service of course is not known, but for the sake of argument suppose all were so drawn, an annual death rate of 100 per thousand would completely exhaust the supply and leave none whatever to fill the demands of the industrial

world. The mortality of those actually engaged in the present war has exceeded 100 per thousand.[1]

This would indicate a casualty rate considerably greater than 100 per thousand per annum, for if the whole 326,000 had been in the service the whole period, of course they were not, the rate would be 107. In some sections the rate is practically 100 per cent. per annum. Of the first 10,000 picked troops sent from Canada, it has been stated that only 12 were in service the first of this year. Also a small British possession agreed to keep in the field 200 men. In less than three years they had sent a total of more than 600.

If we are to judge by the history of the Canadian and English schools during the past three years, unless every effort is made by the schools themselves and by all government agencies interested, there is bound to be a falling off in attendance and graduates. A sane view of the situation demands that this be not allowed but that our technical schools be not only continued but speeded to their utmost. Place no hindrance in the way of those students and young instructors who feel a call to the service. Let them enlist; urge them to enlist. But we who are older, beyond the age when we can be of efficient service in the army, may show our patriotism by remaining in our present positions and intensively preparing those who are physically capable. It is our duty to do everything we can to expedite peace, to "make the world safe for democracy." We must hope for the best but prepare for the worst. We have been talking for two days on what can be done by the schools to aid. We should not hesitate to carry these ideas home and put them into practice. Some may say the war will be short and hence hesitate to make any changes in the curriculum. But let us by all means make the changes, then if the war proves to be short, change back again. People

[1] I have these figures from Mr. H. W. Noble, Nebraska General Agent of the New England Mutual Life Insurance Company:

Canadian troops enlisted..........................	326,000
Killed, wounded and missing......................	87,000
Period considered in years, about..................	2½

in other lines of business are not hide-bound and conservative that they will not make changes. Ninety per cent. of Nebraska's wheat crop this year was winter killed. Instead of equalling last year's yield of 66,000,000 there will be a scarce 6,000,000 bushels. Because the farmers received a good price for the last year's crop and could have easily lived through this year, was that any good reason why they should sit idly down and let the land lie fallow? Instead, they have planted these fields to corn, oats, beans and potatoes, and the usual quantity of foodstuffs will be produced. We may have to live on corn pone instead of white bread but there will be plenty. Should not we, then, who under the law are, on account of age limitations, exempt from conscription, do our bit in an extraordinary way if necessary even as the farmers?

Deutsche Gebiete.

I spoke awhile ago about the craze to secure for instructors in the universities those who had received German degrees. I am glad to say that this is not so great in the engineering colleges as in the others, but perhaps the tendency has been too great even there. We are apt to give too great credit to the longheadedness of the Germans. But I am inclined to think that the spreading of German influence through the schools was truly intentional on the part of those in authority in Germany. Owen Wister[2] quotes from a letter of a German tutor as follows:

"Individual life has become worthless; even the uneducated men feel that something greater than individual happiness is at stake, and the educated know that it is the culture of Europe. By her shameless lies and cold-blooded hypocricy England has forfeited her claim to the title of a country of culture. France has passed her prime anyway, your country is too far behind in its development, the other countries are too small to carry on the heritage of Greek culture and Christian faith—the two main components of every higher culture

[2] "The Pentecost of Calamity," by Owen Wister, The Macmillan Co., New York.

today; so *we* have to do it, and we *shall* do it—even if we and millions more of us should have to die."

Wister's comment is, "A cultivated student, a noble nature, a character of promise, Prussianized, with millions like him, into a gibbering maniac, and fleeing into a caldron of blood!"

If Germany's system of education could thus transform into "gibbering maniacs" her own sons, the autocracy might well reason that the germs would inoculate with the same malady our youth who came there to study in her universities.

It may be argued that this is a sporadic case. Let us quote once more from the same work of Wister. This time it is a letter from an American parent living in Berlin who placed his children in a school there:

"The text-books were unique. I suppose there was not in any book of physics or chemistry that they studied an admission that a citizen of some other country had taken any forward step; every step was by some line of argument assigned to a German. As you might expect the history of the modern world is the work of German heroes. The oddest example, however, was the geography used by Katherine. (His daughter, aged, thirteen.) This contained maps indicating the Deutsche Gebiete (the German "spheres of influence" in other lands) in striking colors. In North and South America, including the United States and Canada, there are said to be three classes of inhabitants—negroes, Indians and Germans. For the United States there is a black belt for negroes and a middle west section for Indians but the rest is Deutsche Gebiete. Canada is occupied mainly by Indians. The matter was brought to my attention because one of Katherine's girl friends asked her whether she was of negro or Indian blood; and when she replied she was neither, her friend pointed out that this was impossible for she surely was not German."

Mr. William Archer has compiled a volume to which he gives the name "Gems of German Thought," which is made up of quotations from books and pamphlets by German writers of prominence and shows conclusively that the idea that Germany is the greatest, most intelligent and wisest of all nations,

has fully permeated the entire nation. Mr. Archer states in the preface that he "doubts whether the literature of the world can show a parallel to the amazing outburst of tribal arrogance, unrestrained and unashamed," of which his book contains "but a few scattered specimens." According to these writers it is the divine mission of Germany to dominate the entire world. We have time for only a few short quotations:

"It is no foolish overvaluation of ourselves, no aggressive arrogance, no want of humility, when we more and more let Bismarck's faith prevail within us, that God has taken the German nation under His special care, or, in any case has some special purpose in view for it." "On the German God," by Pastor W. Lehman.

"We hope that a great mission will be allotted to us Germans . . . and this German mission is: to look after the world." Pastor G. Traub, "Der Krieg un de Seele."

"We want to become a world people. Let us remind ourselves that the belief in our mission as a world people has arisen from our originally purely spiritual impulse to absorb the world into ourselves." Prof. F. Meinecke, "The German Uprising of 1914."

These are but the echoings of the great war writers of Germany. The Superman of Nietzsche is the German as he sees himself. Bernhardi's arguments in favor of war are statements of how this Superman is to prove his superiority. Treitschke implies that a state must either rule or be ruled, therefore Germany must be the ruler of the world.

Not content with propagating German kultur through the media of their own schools the Germans have formed alliances, clubs and societies in the United States and through their political influence compelled the teaching of the German language in the grammar grades of the common schools. The German education has been such that it has led its devotees to believe that it is the best in the world, that German civilization is the highest, that German culture is the finest; it has led to an overestimated belief in her own greatness and a contempt for the rest of mankind. The Prussianizing of the world is

the all important thing; everything else must be submerged to that one idea. Treaties are but "scraps of paper," international law mere formalities to be broken at the demand of German interests; the violation of a small nation's neutrality and the practical enslavement of her people are but means to what she thinks to be a justifiable end. I call upon the school men to denounce such a propaganda.

Not All Germans Disloyal to America.

I do not wish it to be inferred that I believe all Germans beset with the Hohenzollern ideals. I know many native Germans who are loyal Americans; many of them, and many more who are the sons of native Germans, will gladly take up arms in defense of democracy; many men who have received a German education see through and condemn the conceit of Prussianism. Those in authority in Germany could not believe it possible for the German-American to be anything but wholly German at the last extremity. It was freely predicted that in case of war they would refuse to bear arms, they would resist to the point of disrupting the government. They thought the German alliances had set up little Germanies in the United States and would, rather than fight the fatherland, raise up governments of their own. Now that it has come to a show down and thousands of Germans, native and sons of natives, have not asked exemption from conscription, they are beginning to see, but their befogged eyes do not yet penetrate to the truth. The semi-official *Cologne Gazette* declares the German-Americans to be their "best allies" and constitute a "sounding board" for the German cause in America. It further adds:

". . . our compatriots have hitherto not pursued a policy of political separation. They therefore do not constitute any national group of their own in the political life of the union, which is not a constellation of nationalities. Their direct influence, on the other hand, is all the greater, inasmuch as all classes, professions, political circles and other sections of

American society are permeated to the highest degree with German-Americans. They inject into American public opinion an element of restraint and circumspection which already has often been the cause of embarrassment to Herr Wilson and his English friends. We may be certain that they also at this hour are at their post."

OUR DUTY IS TO TEACH TRUE DEMOCRACY.

I presume the flocking of young men to German universities, the eagerness with which we have employed German graduates in our best colleges, and the boldness with which these people heretofore have advocated and defended German ideals, has had much to do with solidifying the idea in the minds of the autocracy that German kultur permeates "all classes, professions, political circles and other sections of American society." Shall we not, fellow teachers, disabuse their minds of these false notions? Ought we not, rather, to teach our students that the two extremes of political government, anarchy and autocracy, are both bad, and that the golden mean is true democracy? May we not define true democracy as a republican form of government which partakes of anarchy only so far as to allow individualism free expression with the understanding that always the majority shall rule; which partakes of autocracy only so much as will insure the rule of the majority and efficient administration? May we not teach every young person who comes under our influence the symbolism of our flag which stands for true democracy, which is no respecter of persons, protecting all and giving to all, no matter from what land they may come, equal rights and the privilege of sharing with us in our boundless opportunities. In return for this protection and freedom, gratitude and common decency demand loyalty to our country and to our flag. It is a vicious pup that bites the hand that feeds him. And those at the head of our public and semi-public schools, colleges and universities can do no more patriotic service than deny employment to any who hereafter parade German culture above American.

I can close no better than by quoting an exalted tribute to the flag, written by Dr. Hartley B. Alexander, one of my confreres in the University of Nebraska.[3]

LIBERTY.

Thou flag of my country—
Thou banner of my native land—
Thou Stars and Stripes of mine America—
Hail, hail, hail! Forever, hail!

I behold thee, and my heart leaps high,
Greeting thy rushing waves with answering wave
Of blood resurgent, till my body rings
With the clear hymn of liberty and thee,
Flag, flag of my country.

Conceived thou were in peril,
Painted in hour of war,
And thy reddened stripes furrow thy field of white
As war's red share furrows the white of peace,
Telling what men have dared and done for liberty!

Conceived thou wert in peril, and in hope,
And all thy blue—star-spangled like the skies—
Sings of the watches of the night
That men have kept in love of thee,
In love of thee and of the emulous stars
Which send hope's answer back from heaven.

Concord and Trenton, Orleans and Gettysburg,
How many fields have seen thy tattered folds
Wave the last triumph to the eyes of men
Who sang their death-song to thee!
On how many seas
Have tall ships borne thee at the peak
Mid thundering guns and wild careen
Of fire less ruddy than men's fiery hearts!
Thou flag of my Country,
Men have died for thee!
With cheers on their lips and gladness in their souls,
With faith in thee and me!

[3] From the 1917 Pageant of Lincoln commemorating the semi-centennial of Nebraska, words by Hartley B. Alexander. Copyrighted. Used by permission.

O save me to thee!
Be thou mine and my country's prayer—
Into my life let thy bright image burn
Like purifying flame, like tempering steel,
Like heaven's night, star-glorious!
Make thou my spirit clean,
Clean in the love of liberty and thee,
Uncleft in truth and loyalty!

Let thine ensanguined stripes—
Like th' ensanguined stripes on Christ's white body—
Bid me be noble ever!
Let all the watching stars
Of vigilant heaven shine
From thy clear blue on me, and in me find
Such constancy to thee as heaven's is
In all her constant stars!

O flag of my Country,
Be for me the purge that shall bear far—
Yea, in my blood if need be—
All deed, all thought, all love,
That measures not thine honor and thy troth!
Make thou of me a blade of strength,
A fortress stone, a staff
To raise thee, raise thee, ever!
Let not nobility
Perish from America!
Flag, Flag of my Country!

THE BUREAU OF STANDARDS.

BY S. W. STRATTON,

Director, Bureau of Standards.

After listening to the very admirable speech of the Secretary of War, I do not feel at all competent to measure up to his standard.

I appreciate the fact that all of you are interested in the questions pertaining to standardization. Some of you are familiar with the work of the Bureau of Standards and a great many are not. The term "standards" has come to mean very much more than it did formerly. For example, standards of measurements now involve not only standards of length, capacity and so on, but the standards of electrical measurements, heat measurements, optical measurements, and standards of all physical quantities that are to be measured. Today this necessitates the maintenance of physical and chemical laboratories equipped with facilities of all kinds and covering the widest range. Take, for example, the measurement of temperature alone. This necessitates the production of the highest as well as the lowest temperatures, and all of the problems that involves. It necessitates the examination and testing of all of the instruments by which temperatures are measured, whether it be for the measurement of the highest or the lowest temperatures.

However, these are just the beginning of standards. We have another class of standards known as physical constants, as engineers know that in all sorts of computations it is necessary to have authoritative values of these constants, such as the mechanical equivalent of heat, the latent heat and specific heats substances. Many of these have been determined long ago at a time when facilities available were inadequate, and

must be redetermined with modern facilities and a precision that is now demanded by the engineer. It is a mistake to assume that the engineer is to be satisfied with approximate measurements, and fairly good data. The demands of the engineer are for the utmost precision. The bureau has recently finished a series of investigations for the refrigeration engineer. It extended over a period of five years or more and meant the measurement of most of the physical constants involved.

No more difficult problems have presented themselves to the bureau or to any physical laboratory than these measurements in heat. The refrigeration engineers were not satisfied with mere approximate values, they wanted the values to the utmost degree of precision attainable within reason, and have said, "If we do not want the full value, we can cut it off, but if you make approximate measurements we can never pass to precise measurements." That may be taken as an example. Physical constants are standards in every sense of the word, as much as standards of measurements. They are standard values.

Then again there are standards of quality. We are familiar with the standard of quality as a specification. A great deal of work has been done by manufacturers and engineers getting together and agreeing as to specifications. But in formulating these standards of quality or specifications, many questions arise as to what shall or shall not be allowed, and these questions often involve the most serious scientific investigations. We are often brought face to face with these imperfect specifications. The bureau serves as a testing laboratory for many government purchases, and that gives ample opportunity for coming in contact with these specifications and finding out where they should be improved.

The bureau coöperates with engineering societies, especially with industrial organizations, in bringing these various interests together. In this problem of the standardization of quality, these vacant spots, as it were, weaknesses in the specifications, are brought to the surface—these difficult questions give to the bureau suggestions as to what lines of work to pur-

sue. In other words, we endeavor to fill in the gaps, not to repeat nor to do work over again, nor to do unnecessary work, but to secure the experimental data necessary in improving the standard.

Passing on from these standards of quality, with which you are familiar, there is another class of standards. We speak of them as the standards of performance. In the purchase of machinery or instruments and devices of all kinds—it does not matter whether it is an electrometer, a dynamo or a telescope—it is necessary in drawing the specifications, as we call it, to state the performance required of that instrument or device. We still call it a specification in ordinary terms, but it is a standard of performance, a precise statement of the performance of that machine, instrument or device, as well as a description of the methods by which this performance shall be measured. It is just as important that we should have a clear, clean-cut definition of the standard of performance and the method of measuring it, as it is that we shall have standard weights and yardsticks, if we are to have agreement between the manufacturer and the user of these devices.

There is yet another form of standards where uniformity is desired—standards of practice. In the early days of electricity it was of no consequence whatever if the ground was used for the return part of the circuit; but at the present time, with the enormous development in the use of electricity, it is not to be thought of in all cases. The use of the ground as a return current must be regulated. It must be used under certain conditions. In the case of the telephone, we have in many cases wires overhead. Along comes long-distance electrical power transmission with its high potential current, with the wires overhead, and there arises disputes in a great many states and cities as to which set of wires has the right of way. Again, city officials, state officials, public service commissions, and other bodies who have charge of the regulating of these things, find it necessary to incorporate scientific definitions. The laws of the country, whether they be national, state or municipal, are full of the most absurd kinds of definitions of

scientific matters. Not long ago a locomotive in going from New York to Chicago, if it should make a continuous trip, would have to adjust its headlight to suit the laws of each of the states through which it goes. There are many regulatory laws in the various states in which we find these discrepancies, because the people charged with the enacting of the legislation or the regulations are not familiar with the scientific matters involved.

We speak of these as standards of practice, and the question is, what is to be the standard of practice in each of these cases, which is scientific to begin with, which is fair and just to the operating company on the one side and to the public on the other? There are thousands of such cases.

These are but additional cases to illustrate the fact that the terms "standardization" and "standards" involve a great deal more than they used to. "Standardization" involves questions in all the branches of physics and chemistry, as well as other branches of science—but especially physics and chemistry; it involves also the closest working relation between the scientist and the manufacturer or the engineer.

It is to be regretted that the average manufacturer holds aloof from scientific work. I have often said that if called upon to name the most important part of the work at the Bureau of Standards, I would say that it is the bringing together of the manufacturer and the scientist, the introduction of real scientific work into the industries—I am using the term "industries" in a broad sense, involving engineering as well. There is not a single case of these standards that is not involved in the industries somewhere. No one is more interested in the standardization of the quality of material than the one who makes that material. The bureau may be undertaking investigations to determine why a cement fails; engineers have been content for many years to say that cement shall pass certain specifications; if it does not, it is thrown out and rejected, that is all there is to it. What we really ought to know is why the cement failed; the underlying physical or chemical principles involved, in order that we may tell the mills how

to make better cement. That is true of all the different kinds of materials.

These standards are not all set up arbitrarily. Indeed, very few of them are. I have often felt that the bureau was to be congratulated in having no police duties. The Bureau of Standards has not a single such duty. Standardization is usually accomplished by bringing together typical users and manufacturers. It is the user of an article or a machine that knows what is wanted or when materials fail and very often their statements lead to the bringing together of the manufacturer and the user. When the bureau finds that there is need for standardization in any of the lines that I have mentioned, a number of interested people are brought together, typical users, typical manufacturers or typical engineers, as the case may be. At such discussions several things are brought out. We are especially concerned in those things which need scientific investigation, those things connected with standardization which must be based upon scientific data. If such data exist somewhere, we will get them. If not, we will undertake the investigations necessary to produce them. The outcome is generally an agreement upon the part of all the parties interested, and when the parties interested have been heard in the establishment of the standard, there is little need of a law to enforce it. It is done by common consent, and there is seldom any difficulty.

You will be interested to know of a case that came up this morning, just before coming to this meeting. I am going to mention that case because it is rather different from those which come up ordinarily, because you would say it is foreign to the work of the Bureau of Standards. It is the standardization of shoe lasts.

This is a new subject. It came up this morning, and the program was tentatively laid out. A representative of one of the largest shoe manufacturers in the country came to the bureau, representing ten or twelve large shoe factories, stating the necessity for the standardization of shoe sizes. I replied, "We know of the necessity for the standardization of shoe

lasts, since the subject has come up several times. But we are not experts in the making of shoes, in the making of lasts or in the examination of feet. We are not experts, but we can bring together the manufacturers of shoes, the manufacturers of lasts, the people who are dealing with the public and the representatives of the army and navy who are large purchasers of shoes. We will discuss the subject, and in the end they will agree among themselves, first, whether we ought to have a standard, and second, what the standard ought to be. If it is agreed that there ought to be a standard and what it ought to be, then the bureau can help in putting that into a concrete, scientific form. In prescribing the definitions and in promulgating this standard, we will assist in every way to preserve the standards if they are of a nature to be preserved, and so on; but the function of the bureau is to help you to help yourselves, and not to do it for you."

This is rather an extreme case, but it represents the situation as we have frequently to meet it. It is not the function of the bureau to arbitrarily establish these standards, but, first of all, to bring together the people who are in a position to establish them, and by bringing together the best knowledge of all concerned, to produce something good, something that they can all agree to. In this of course we have the assistance of engineering societies, of industrial organizations, technical societies, and the public. Many of them meet at the bureau during the year.

We have perhaps many such conferences at the bureau. A month or two ago we had a conference of textile representatives; very little has been done in the standardization of textiles. You who are accustomed to look at things in a scientific way would be surprised at the condition we sometimes find standardization in some of the industries. There is little uniformity in textile testing. There is need of scientific work in the textile industries, but throughout the country they are awakening to the value of these things and the greatest interest is displayed by the industries in the utilization of scientific work.

The bureau has been very much interested in another matter; and that is the introduction of our own materials where foreign materials were formerly used. The bureau has done a great deal along this line, but at the outbreak of the war more of this work was thrown upon us and in two or three years more than we normally would have in ten years. We have been brought face to face with many cases of this kind. For example, in the metal industries, many of the crucibles used were made of a foreign clay, a foreign graphite. Think of the conditions that existed when those materials were cut off. Fortunately, the bureau had been examining these refractory materials—a most important subject, because they enter into so many different lines of industry.

It came up first from the standardization of certain products for the government service. We handled that in the way I have spoken of. It pointed to the fact that there was no uniformity in the specification of these materials, and that the quality of many was poor, and so our ceramic department started to work examining refractories from all over the country, and it found that by certain mixtures we could compound a refractory clay which was even better than the foreign product. There remained then the problem of getting the manufacturer to use these clays. They often follow the path of least resistance, and in this case, one of the largest manufacturers would pay no attention whatever to the fact that we could get American clays until a year after the war broke out. He stated in his letter that they had had a year's supply on hand, but that it was exhausted.

We are just at present very much concerned in regard to optical glass. All of the glass from which our optical instruments, including gunsights and periscopes and such, were made from imported glass. No other industry has been so much in the hands of a few workmen, who cover the whole process in a cloud of secrecy, as this industry has been. Even in the old countries the processes have been in the hands of a few people, handed down from father to son for many years, and not made public. It became apparent that we

would have to go into the technique of the making of optical glass, and learn how it was actually made in the factory, before we could help our own industries. The war broke out and cut off the supply of foreign glass even before we were thoroughly prepared in this line, and now every effort is being made by the Bureau of Standards and by two or three manufacturing plants to produce optical glass with considerable success. It will not be very long before these industries will turn it out. But think of the condition we were found in simply because we were importing all this material from foreign countries. That is only one of perhaps a hundred cases, that I could mention.

The present war has taught us many very valuable lessons, and none are more valuable than that we must develop and depend upon our own resources as much as possible. It is through the bureau's work in its standardization of all these materials that it became familiar with the materials. You can not separate the two; you can not separate the standardization of material from its manufacture. The bureau has been of the greatest assistance to manufacturers in this time of need in the adaptation of our own materials and in using them to a better advantage. They often make the mistake of thinking that when the foreign thing is gone, some new material of our own can replace it under the same conditions. It took years of practice to find out how to treat the foreign materials, and it is going to take some time to find out how to use the new ones. They often need a different treatment altogether, but in the end it may turn out, if handled properly, a better material, and it would surprise you to know what progress has been made by the industries in the last two years in the introduction of our own materials and the cutting off of those things that we thought must absolutely come from abroad.

There is just one other point I wish to make, and that is that we meet from day to day a condition which you have long known, and that is the necessity for breaking down the hard and fast lines between scientific work and engineering.

Some engineering practice is scientific work of the highest order. There is really not much difference. We are glad to find out that the engineering educators throughout the country are appreciating more and more the value of instruction in investigational work. Not so very long ago it was impossible to find a graduate engineer who had any idea of how to undertake an investigation, how to do original work, but it is the most valuable thing that he gets in school. Today it is quite different. Nearly all of the educational institutions are looking toward engineering investigation, which is nothing more than a particular kind of physics and chemistry, a little different application of it. I believe that this training in research, or the ability to do research and to undertake an investigation is just exactly what the engineer needs, we need more of it at the bureau, therefore anything that you do to help us to secure men trained as investigators will be of the greatest assistance, not only to the Bureau of Standards, but to many government bureaus engaged in scientific work. On the other hand, if there is anything that the bureau can do to assist you in your work of instruction, please call upon us. I believe we can provide you with much valuable information as to the questions relating to materials, and especially in the providing the calibration of instruments needed in laboratory work or investigations—the bureau will be delighted to coöperate with you. I hope that a much closer relationship may be brought about between engineering institutions, the engineering work of the various educational institutions, and the scientific work of the government, especially the Bureau of Standards.

I thank you very much, gentlemen!

ADDRESS.

BY HON. PHILANDER P. CLAXTON,

U. S. Commissioner of Education.

I had not expected to have the honor and pleasure of speaking to you. I detailed for this duty Dr. Capen, specialist in higher education in the Bureau of Education. I think he has been with you. I came in only that I might hear, for a few moments, your discussions. I wish to express my regret that I can not be with you through all your meetings. I can only say to you that whatever the Bureau of Education can do in any way to facilitate your work, to help forward the great cause of education in engineering, it will do gladly. It is your agent and your servant for that purpose.

Just now, our attention is called with emphasis to the importance of engineering education in its broadest sense. Probably most of you have read the book "Eclipse of Empire," written by Dr. H. B. Gray, an English schoolmaster. Though on so dull a subject as the importance of technical education, this book has been one of the "best sellers" in England, more than 100,000 copies having been sold, I am told, since its publication last fall. In this book, the author calls attention to the fact that, reduced to the same basis of population, Switzerland would have three hundred chemists, Germany two hundred and fifty, France seven and England six—forty-two times as many for Germany as for England in proportion to population—and he contends that this is one of the serious difficulties England is facing just now.

When we entered into the war, the first demand made of us was for several thousand skilled men to go to England and France, to repair and rebuild their railroads. Following quickly upon this, we were told that Russia would need several

thousand more. The number of thousands we shall have to send to these countries and to Italy we do not yet know. Before the war is over, if the war should be long, we shall have need for large numbers of engineers in this country to repair our railroads and other means of transportation, which will be taxed during the war as never before. The present supply will soon be absorbed and there will be a demand for every trained man in any phase of engineering that can be turned out by all our colleges, universities and schools of technology.

I was delighted to hear the answer to the first question that I heard as I came in as to what would be the policy in regard to men in institutions preparing for this particular kind of service—to hear the answer that because of the very great need of the service which they were rendering or preparing to render, they should stay at their post and not go into active service at the front. The time has come when wars are not won by brute force, and they are not won by mere physical bravery and gallantry. There is no longer the charge on horseback, and it is no longer the schemer who can plan this or that maneuver; but wars must be won by scientific knowledge, by technical skill. It is largely a matter of engineering as well as a matter of the production of food and of the means of warfare.

When the war is over there will come to this country such a demand for men of scientific knowledge and technical skill, for engineers, if you please, as never came to any country at any time before in the history of the world. China and Russia are just entering, no doubt, upon periods of large and long-continuing development. One third of all the population of the world lives in these new republics; their territory is extensive; and their resources are large and varied.

When the war is over all European countries will be exhausted. They must be reconstructed and rebuilt. We shall find ourselves the leading nation of the world in industries and commerce. With more wealth than any other nation, leadership which would otherwise have come to us gradually

will have been thrust upon us suddenly because of the world war. For the rebuilding of the world there will be need for scientific knowledge and technical skill to a degree not yet attained by any people. Our own country is the only one that can hope to furnish the trained men for this work. There is one other, possibly, and that is Japan. The colleges and universities of Europe are practically empty now. Some days ago I talked with Dr. Parkin, who has charge of the Rhodes Scholarships and he told me that at Oxford this year they have three hundred and fifty undergraduate students as compared with thirty-five hundred in the years before the war; and this same ratio holds throughout the colleges, universities and technical schools of England.

The conditions are no better, probably not so good, in France. And the same is true in greater or less degree of all European countries engaged in the war. For three years their colleges have been practically empty. For years after the war they will be comparatively so. Their younger professors are on the firing lines, dying in the trenches. Large numbers of their recent graduates are going the same way.

We are the only country that has entered the war in that deliberate way that makes it possible to plan for the future. France had to rush into it overnight. England had to gather volunteers from all possible sources and rush them across the channel. There was no opportunity for them to plan for the future; there was no choice. These countries had to take the men who were most ready and who would volunteer immediately, and they took them and poured them into the trenches, and most of them never came back. We have already been in the war for something like three months, and are now talking about raising our army. We are here now discussing leisurely the best means of entering it and how we shall do it. We shall, I think, be very foolish if we do not find a way to keep up to the highest possible grade of efficiency our educational institutions, especially those that have to do with preparing men for the work that will be needed in later years of the war,

if it shall be long, and which must be done immediately when the war is over, the work of rebuilding the world.

This is a time, then, when we in the United States must be interested in engineering education in all its branches as we have never been before, for the development of our own country, for the establishment and development of our own industries, and of our world-wide commerce, and for supplying to the rest of the world what the rest of the world can not supply to itself for the next decade or two.

We in the United States, with such wealth as no other country ever had before, able to float liberty bonds to the amount of two billion dollars or seven or ten billion dollars at the cost of only a fraction of the income of the people for a single year, with schools richer than the schools of any other country, must respond to the demands that are made upon us, and with far-sightedness we must make the provision to meet the demands that will be made upon us in the years to come.

I said our schools are rich. Let me call your attention to the fact that in 1892 the colleges, universities and technical schools reporting to the Bureau of Education had working incomes amounting to approximately $17,000,000. In 1915 their working incomes of the schools was something more than $120,000,000. Their endowments had increased more than two hundred per cent. Out of our hundred millions of population and some twelve or fourteen millions of men between the ages of eighteen and thirty-one, we should be able to send to the front all the men needed for the trenches, produce all the food crops needed, build our ships and manufacture munitions of war without emptying our colleges, universities and technical schools. For the strength of the country in war and for its welfare after the war is over, we should see to it that the attendance in these schools is larger than ever before. This is in full accord with the policies of the administration.

Last May I sent to the principals of all high schools in the United States a letter addressed to the boys and girls graduating in the high schools this year, and containing a plea

that these boys and girls should enter college or normal school next year in large numbers. Something like two hundred and twenty thousand boys and girls graduated from the high schools this year; last year about ninety thousand entered college or normal school. One hundred and fifty thousand should enter next fall. Boys graduating from the high schools are eighteen or nineteen years old. They are not wanted in the army. Maturer men are wanted for that service. If the colleges will readjust their attendance, these boys can attend college and still be helpful in the production of food and in the industries.

I have endeavored also to emphasize the fact that every man now in college, especially the men in the engineering departments of various kinds, should remain in college until he has finished his course, unless he leaves college to take some position or to do some work, which position could not be filled so well or which work could not be done so well by any other.

Let us impress upon the young men in our colleges, universities and technical schools that they may serve their country better by remaining in college and gaining preparation for the service which will give value to the work of themselves and millions who are willing to fight in the trenches and do what may be called the unskilled work of war, heroic and devoted enough but without avail unless wisely directed and supported by men of scientific knowledge and technical skill. It is a wonderful opportunity for service, not only to the individual who is being educated, and not to state or nation alone, but for service to the world.

A NEW ORGANIZATION OF HIGHER EDUCATION FOR NATIONAL SERVICE.

BY S. P. CAPEN,

Specialist in Higher Education, U. S. Bureau of Education.

It is a privilege to meet with your Society. It happens to be my good fortune, or misfortune—as you choose to regard it—to attend practically all the meetings of all the associations which deal with higher education in the United States One gets to be somewhat of a connoisseur in association meetings. As a result of three or four years of this type of experience, I am perfectly willing to go on record to the effect that the discussions of this Society, as I have observed them, are generally more fruitful and more definite than those of almost any other in the United States. So, although I am a layman on the subject of engineering, it always gives me great pleasure to be present at your meetings.

My function on this occasion is that of a chronicler. The events that I have to record, I presume, are known to many of you. I think they should be known to all of you, which is the excuse for my appearance.

I presume we have all watched with interest and concern the part which the universities of Europe and Canada have played in the war, and the effects of the war upon these institutions. We have seen with a thrill the noble response which university men in the allied countries have made to the call for soldiers, and their unhesitating sacrifices. We have seen, as your president has pointed out, that this is primarily a war of engineers, of chemists, of physicists, and of doctors. I suppose you have also observed with the greatest distress that foreign institutions have been largely stripped of both students and instructors as the war has gone

on. Probably there is not a college man in the United States who did not hope that when the United States entered the war, means might be found to prevent the disastrous diminution of our supply of trained men, and to utilize the colleges for the maximum of service.

The Committee on Engineering and Education of the Advisory Commission of the Council of National Defense came to the conviction early that if the United States were to avoid a repetition of the experiences of European and Canadian universities, it was desirable that a comprehensive policy of coöperation between the government and the higher institutions should be established. Accordingly, the chairman of the committee, Dr. Godfrey, called a meeting of the representatives of various associations of higher educational institutions, which was held here in Washington on the fifth of May. I presume that most of you have read about it. Possibly you have read the complete account of the conference. I will merely indicate very briefly the representation and the principal matters which were discussed.

The conference was attended by representatives of the National Association of State Universities, the Association of Agricultural Colleges and Experiment Stations, the Association of American Universities, the Association of American Colleges, and your own Society. There were present also delegates from a number of independent institutions, not members of any of these associations. Altogether, 187 higher institutions sent representatives to this conference. The conference unanimously adopted, after a day's session, a statement of principles and certain resolutions. The main points in the statement of principles, very briefly, were these:

First, it emphasized the unqualified desire of the colleges to place all their resources, human and material, at the disposal of the government for as long as might be necessary.

Second, the conference urged that students below the age of liability to the selective draft remain in college and avail themselves of the opportunities offered by the colleges

wherever possible, in order that they might be able to render still better service when their time came.

Third, it urged the modification of calendars and curricula in order to conserve the students' time better, and to meet any needs which the government might indicate. As an example of this type of reorganization, the four-quarter year was suggested.

Fourth, the conference pointed out that because of the supreme importance of applied science in the present war, students in technical courses, such as engineering, medicine, and agriculture, were rendering or were in the future to render services more valuable than if they should enlist at once in the army or the navy.

Fifth, the conference recorded its belief that all colleges should include in their courses of study military science, and should as far as possible coöperate with the War Department under the terms of the National Defense Act of June 2, 1916.

The Council of National Defense endorsed these principles, and adopted the resolutions which were presented also for its consideration by the conference. The resolutions provided, in brief, first, for the issuance through the Bureau of Education and the States' Relations Service of the Department of Agriculture of statements of the plans of the Government in all its departments, as far as these might concern colleges and universities; second, for the circulation of accounts of the methods which had been employed by the allied countries to adapt their educational institutions to war needs; and, third, for the continuous publication, after consultation with federal departments, of statements of the needs for technical, military and general training which the colleges might fulfill, together with suggestions as to how they might organize themselves the better to meet these demands.

This, I take it, is familiar to all or nearly all of you. The conference left behind it, however, a permanent committee composed of twenty-four persons—university and college administrative officers, for the most part—representing geographically the whole country. This committee has been

charged with carrying out the purpose of the resolutions, and with serving as a permanent organ for the consideration of college policies until some other means might be devised. The committee has held four meetings and has transacted a good deal of business. A large number of questions have been discussed and handled in some fashion. The most important of its transactions, however, I think I may summarize under two or three heads.

It was apparent from the outset that many of the questions which would come before the committee would involve secondary schools as well as colleges. Consequently, the committee appointed at its first meeting a subsection of school administrators and secondary school principals to consider and advise on the questions relating to secondary institutions. That subsection has held one meeting.

Very many offers of service have come to the committee, through its chairman. Persons of expert capacity have written to him and requested to be placed where they could do the most good in connection with some government department. There have been hundreds of such offers in the last two months. The committee had no facilities for placing these persons. Eventually it decided to ask the coöperation of the Intercollegiate Intelligence Bureau, a voluntary organization of which probably most of you know, established in the first days of the war for the purpose of putting persons qualified to serve in other than military capacities in contact with the appropriate operating departments of the government. The Intercollegiate Intelligence Bureau has taken over all of these offers of service, and has endeavored to place the persons making them, as the needs of the government departments have manifested themselves.

Your president has alluded to the fact that there has been some uncertainty as to the arrangements which might be made between the colleges and the War Department with respect to military training. That has been, in fact, a source of considerable concern to some colleges. Until more definite statements were forthcoming than any which had been made

up to a month ago, colleges could not shape their plans for the future. The committee received many inquiries bearing on the matter. Finally, about a month ago, it put this material together in the form of a memorandum which was submitted to the War Department, asking as definitely and specifically as possible what the colleges might expect in regard to the continuance of Officers' Reserve Training Corps units as already established, in regard to the establishment of new units, in regard to possible employment of instructors other than regular army officers, etc. Additional memoranda have since been sent to the Department as new questions have arisen. To each of these communications the committee has received an equally definite and specific reply from the War Department covering all the points raised. The first of these replies has just been published. Probably it reached your institutions just about as you were leaving them.

Unquestionably the most intricate and serious task which this committee might have to undertake would be the task of proposing any changes in the curricula of higher institutions. It has not gone very far in this direction as yet. It has, however, taken two steps which may be interesting. A series of suggestions for the adaptation of courses for young women, in institutions having women students, has been approved by the committee and issued in a circular by the Bureau of Education. The second step is the appointment of a subcommittee to work with Gen. Black, the Chief of Engineers of the Army, to determine, if possible, what it is that the army chiefly wants from the engineering schools at the present time; what, if any, changes might be made in the curricula of your institutions. This sub-committee, I understand, is to present a preliminary and tentative report later in this session.

The members of the committee have just had a very stimulating and helpful experience. For two days earlier in this week the committee has held a joint conference with a commission representing the universities of Canada. I shall not comment on this conference, for two reasons. In the first

place, the full account of it is shortly to be published, and my time is limited; and in the second place you are just about to hear from President Mackenzie, of Dalhousie University, who has been kind enough to remain over and to tell you at first hand some of the extraordinary contributions, both material and spiritual, which the universities of that country have made to the great cause which is now our cause, too. Finally, the committee has published two circulars and various multigraphed documents.

I think it is apparent that the formation of the committee and the work that it is trying to do are properly designated by the title that was assigned me on the programme. This *is* a new organization of higher education for national service. The direction of education in this country, as we all know, has always been a local affair. There has not even been any central coördinating machinery. The Bureau of Education is primarily a reporting body, without powers except over the finances of the land-grant colleges, and there only with respect to certain of their funds. The Department of Agriculture has very close and definite relations with the agricultural colleges; but again, except for jurisdiction over certain parts of their work which are supported by federal funds, it has no powers. As far as I am aware, neither office desires any extension of authority. In my own belief, it would be unfortunate if federal authority over higher education were much extended. I believe that one of the sources of strength of our institutions has been their complete freedom from anything that savors of bureaucratic domination.

Nevertheless, there has to be a certain amount of organization. Up to date, the organization of higher education has been of the clan type. Higher institutions serving similar purposes have organized for the advancement of those purposes, and sometimes they have organized to defend themselves against what they believed to be the unreasonable tendencies of institutions serving different purposes; but there has been no attempt to unite any two groups, certainly none to unite all the higher institutions of the United States

for a single end. I presume three months ago the suggestion that such a thing could have been done would have been scouted. Now, quite simply and easily, it has come about. Moreover, the institutions thus organized are connected up with the government in such a way that without sacrificing a bit of their independence, either as individual institutions or as corporate groups in associations, they may coöperate with the government in a great and necessary national service.

This constitutes, in my judgment, a new and singularly significant experiment in the direction of education and in the shaping of it to larger national purposes. I believe it may point the way to developments in the whole scheme of public instruction which would have seemed visionary a few months ago.

CHANGING THE ENGINEERING CURRICULA TO MEET THE NEEDS OF THE ENGINEERING CORPS.

BY HOLLIS GODFREY,

President, Drexel Institute.

The war has brought forth a necessity for a maximum of production of the right quality of war material within a minimum of time. To a great degree, however, little or no attention has been given to the necessity of producing a steady supply of trained minds so necessary if the materials are to be used effectively. In its large sense this is the work, in part, of the Committee on Engineering and Education. A small sector of this work concerns itself with the supply of men for the Engineering Corps of the United States Army and it is to this end that this paper is directed.

The problem is this: given the Engineering Corps with certain needs and certain requirements, and given a number of engineering schools throughout the United States, some splendidly equipped and maintained, and others not so well endowed with engineering facilities, to find out the necessity for adjustment whereby, during this present emergency, there may be a proper supply of men trained to take an immediate place in the Engineer Corps, and the means by which this may be accomplished. This problem is not entirely confined within the specific limits which have been purposely set, because not only in the Engineer Corps but in the whole Army and Navy, and indeed throughout our whole industrial organization, there is a crying need for men trained and equipped in the use of engineering method and procedure.

It is deemed advisable, however, in order not to wander too far astray at the start, to confine our discussion of this need

entirely to the Engineer Corps, limited as it is by the study of concrete cases taken from the experience of this body as contained in written records. Whatever conclusion may be reached from an examination of these cases, will serve as a guide in what further adjustment is necessary in view of the whole situation. Through the courtesy of General Black, Chief of the Engineer Corps of the United States Army, we were enabled to investigate the two sets of examinations held for the purpose of determining "the mental qualifications of candidates for appointment as probational second lieutenants in the Corps of Engineers," one on August 21–25, 1916, and the other January 29–February 2, 1917. It will be seen that the first was held at the time when war was still a rather remote possibility, whereas the other came when war was felt to be imminent and more men were thinking of joining the service. A third examination has been held within the last fortnight, but the results are not yet available.

We were fortunate enough to be able to read the examination papers and, through the courtesy of the War Department, to read the answers to them so far as we deemed it necessary. The results of the two examinations mentioned above are given in graphical form. We were not permitted to produce any part of the answers nor to note anything but the most general observations. The questions of the examinations held August 21–25, 1916, are available for your perusal in pamphlet form as they are printed and distributed through the War Department.

In each case the examinations covered these subjects to which were attached the accompanying weights as shown on Chart I.

In the first examination there were forty-three candidates. In the second, twenty-nine, a total of seventy-two. An average of eighty per cent. in all subjects was necessary for passing; while a passing mark of sixty-seven per cent. was necessary in each of the several subjects. On the charts these passing grades as they appear are shown by a red line.

For the sake of clearness we will call the examination held

August 21–25, 1916, examination "A" and the examination held January 29–February 2, 1917, examination "B."

We will now look at the charts in the order in which they are given in Chart 1.

Charts 2A and 2B both show a remarkable standing of the candidates in English. In no instance was there a deficiency, the lowest mark in both was seventy-four per cent.

When examined for a foreign language, the candidates were permitted to elect French, German or Spanish. We were unable to obtain an analysis of the marks according to these three subjects but comparison of Charts 3A and 3B shows that there was a steady increase in the number of successful candidates taking examination B. It is, however, worth while to call your attention to the large percentage of those in both groups who failed to pass their language examinations.

Charts 4A and 4B, presenting the results of the examination in general history, show practically the same results with an increasing success for the candidates taking examination B.

We have covered now the results of three examinations, English, foreign language and history, and, referring to Chart 1, it is seen that these three carry the least weight in comparison with the other subjects

Charts 5A and 5B show, again, that the results of B are of a higher grade than those of A. Chart 5B is a chart of results which one might expect to find coming out of any well taught class in physics.

Charts 6A and 6B express the results in the subject of chemistry. In this particular instance, however, those taking examination A rather than B seemed to have passed more successfully for it is apparent that 94 per cent. taking examination A passed in comparison with 90 per cent. of those taking examination B. Chemistry with English, then, seems to show a better preparation on the part of the candidates than any of the other subjects.

In surveying there is an interesting comparison between examination A and examination B. In examination A only 48 per cent. of the candidates passed, whereas in examination

B, 80 per cent. passed. By reference to Chart 1, it will be found that surveying counts twelve weights and this general flunk in examination B accounts for a remarkably low average which we will discover when we examine Chart 14A in the course of a few moments.

CHART 1.

Relative Values of Subjects.

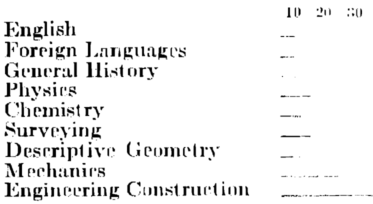


CHART 2A. CHART 2B.

English.

Aug. 21–25, 1916. Jan. 29–Feb. 2, 1917.

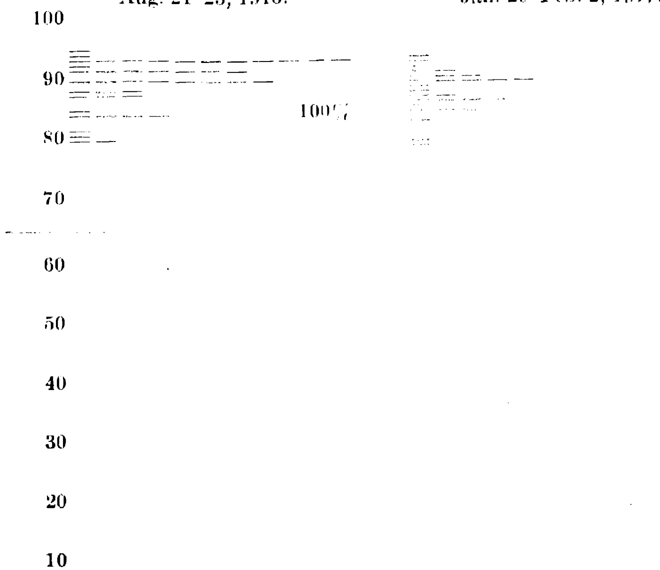


Chart 3a. Chart 3b.

Foreign Languages.

Aug. 21–25, 1916. Jan. 29–Feb. 2, 1917.

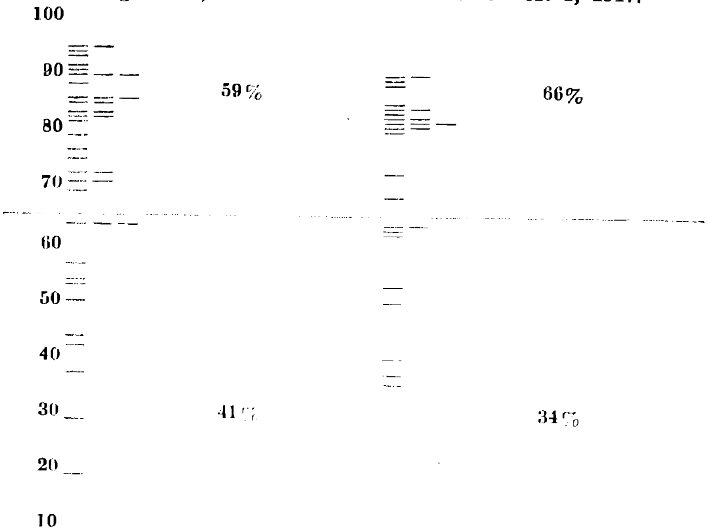


Chart 4a. Chart 4b.

General History.

Aug. 21–25, 1916. Jan. 29–Feb. 2, 1917.

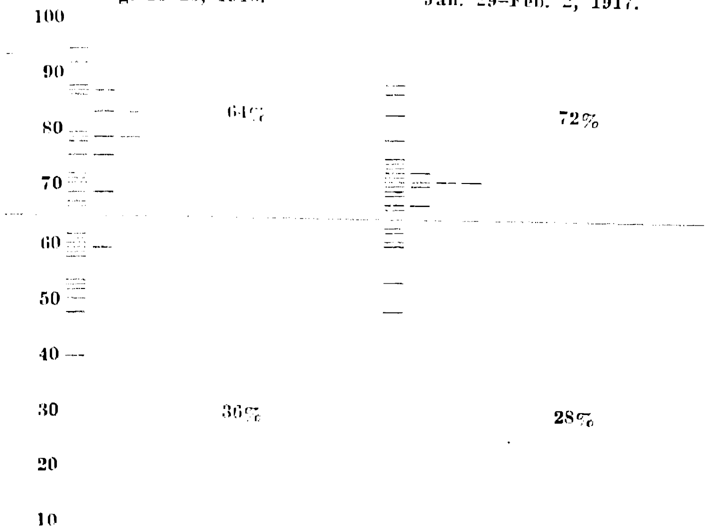


CHART 5A. CHART 5B.

Physics.

Aug. 21–25, 1916. Jan. 29–Feb. 2, 1917.

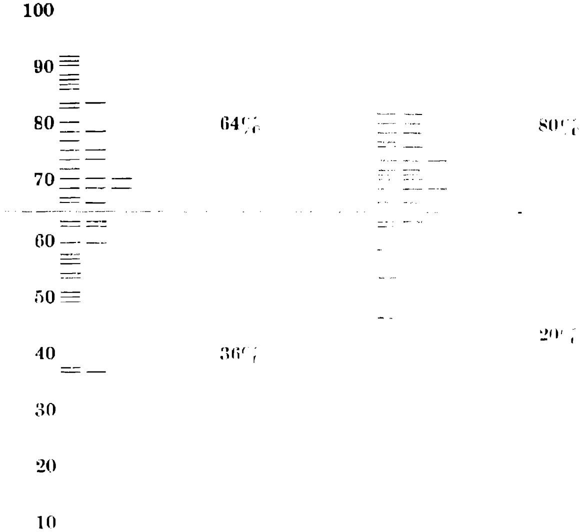


CHART 6A. CHART 6B.

Chemistry.

Aug. 21–25, 1916. Jan. 29–Feb. 2, 1917.

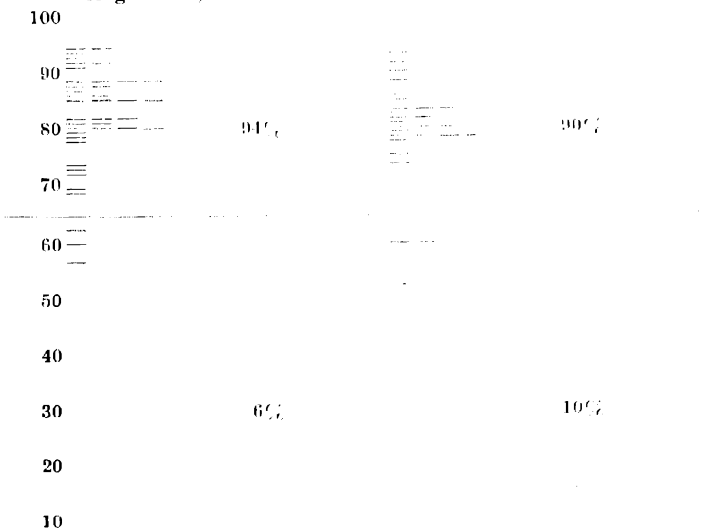


CHART 7A. **CHART 7B.**

Surveying and Astronomy.

Aug. 21–25, 1916. **Jan. 29–Feb. 2, 1917.**

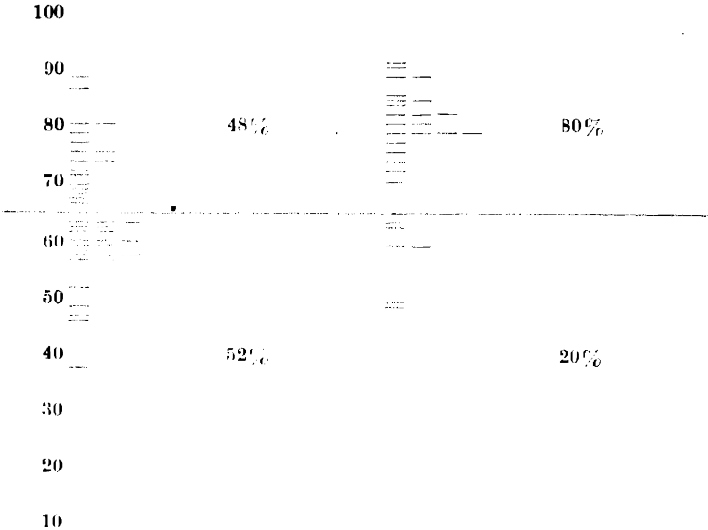


CHART 8A. CHART 8B.

Descriptive Geometry.

Aug. 21–25, 1916. Jan. 29–Feb. 2, 1917.

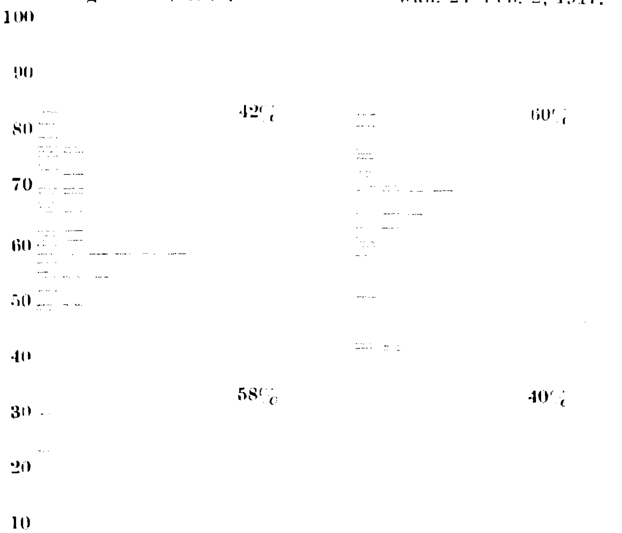


CHART 9A. CHART 9B.

Mechanics.

Aug. 21–25, 1916. Jan. 29–Feb. 2, 1917.

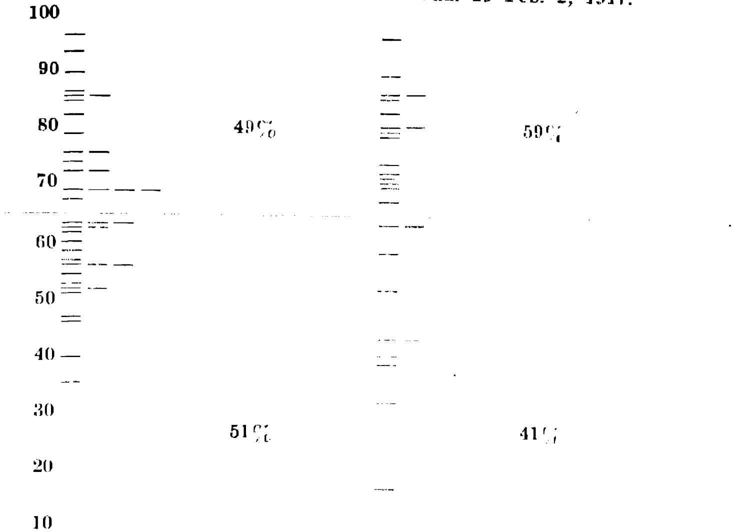


CHART 10A. CHART 10B.

Engineering Construction.

Aug. 21–25, 1916. Jan. 29–Feb. 2, 1917.



Charts 8A and 8B show another general deficiency, this time in descriptive geometry. Mechanics also, as shown in Charts 9A and 9B, indicate a general low grade on the part of those attempting the examinations. Again, examination B indicates far better results.

In engineering construction, by which is meant civil engineering subjects in general, and which we may see from Chart 1, is the most important subject of all, shows most satisfactory results. Very likely the percentage in both cases of those who passed is approximately the same, if, indeed, not better, as any such percentage of passing grades to be found in a first class engineering school. Chart 11 gives a summation of the percentages of those that passed and those that failed in both sets of examinations.

CHART 11.

	A		B	
	Passed.	Failed.	Passed.	Failed.
English	100%		100%	
Foreign language	59%	41%	66%	34%
History, etc.	64%	36%	72%	28%
Physics	64%	36%	80%	20%
Chemistry	94%	6%	90%	10%
Surveying, etc.	48%	52%	80%	20%
Descriptive geometry	42%	58%	60%	40%
Mechanics	49%	51%	59%	41%
Engineering construction	87%	13%	83%	17%
Total percentage	84%	16%	76%	24%

From this table then we may draw whatever there may be concerning the general deficiencies. The foreign languages, although carrying a weight of but 4, apparently are a stumbling block. Physics, carrying a weight of 12, shows fairly good results in B. The same is true of surveying and astronomy. Descriptive geometry, having a weight of 8, is noticeably weak. Engineering construction, on the other hand, the essence of engineering work, is exceedingly strong and in normal condition.

Throughout the course of this report we have seen the dif-

CHART 12.

Subject.	Per Cent. Passed.	Per Cent Failed.	Per Cent. Passed.	Per Cent. Failed.
	A Examination, Aug. 21-25, 1916.		B Examination, Jan. 29-Feb. 2, 1917.	
English	100	0	100	0
Foreign languages	59	41	66	34
General history	64	36	72	28
Physics	64	36	80	20
Chemistry	94	6	90	10
Surveying and astronomy	48	52	80	20
Descriptive geometry	42	58	60	40
Mechanics	49	51	59	41
Engineering construction	87	13	83	17
Total percentages	84	16	76	24

CHART 13A. CHART 13B.

Final Percentage.

Aug. 21-25, 1916. Jan. 29-Feb. 2, 1917.

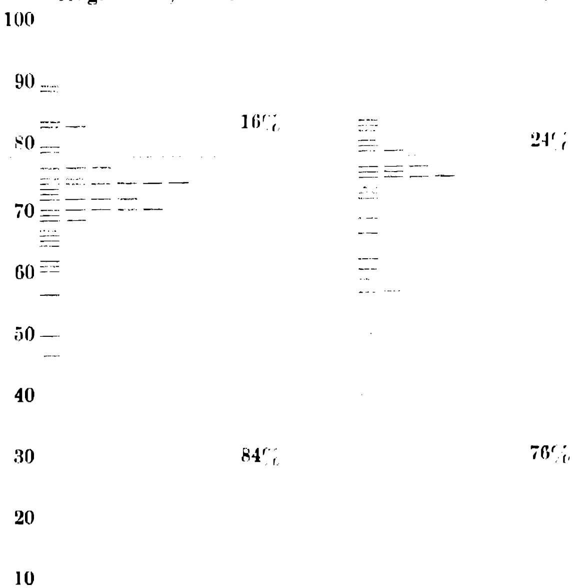


CHART 14A.

Chart of Proficiencies and Deficiencies.

Examination A.

Aug. 21–25, 1916.

English	Foreign Languages.	History.	Physics.	Chemistry.	Surveying.	Descriptive Geometry.	Mechanics.	Engineering Construction.

CHART 14B.

Chart of Proficiencies and Deficiencies.

Examination B.

Jan. 29–Feb. 2, 1917.

English.	Foreign Languages.	History.	Physics.	Chemistry.	Surveying.	Descriptive Geometry.	Mechanics.	Engineering Construction.

ference between the line of success of those taking examination A and of those taking examination B. This difference is shown graphically on Chart 12. We are unable to account for the difference of number between those taking examination B and those taking examination A, but the officer under whom we were able to obtain this material stated that he believed a higher grade of applicant was taking the examination. To be sure, it was not possible for us to state definitely the difference between the two sets of questions nor the question of the markers. We are also aware that the difference in the number of applicants will make a variation in the relation of

CHART 15A.

Chart Showing Relative Deficiencies.

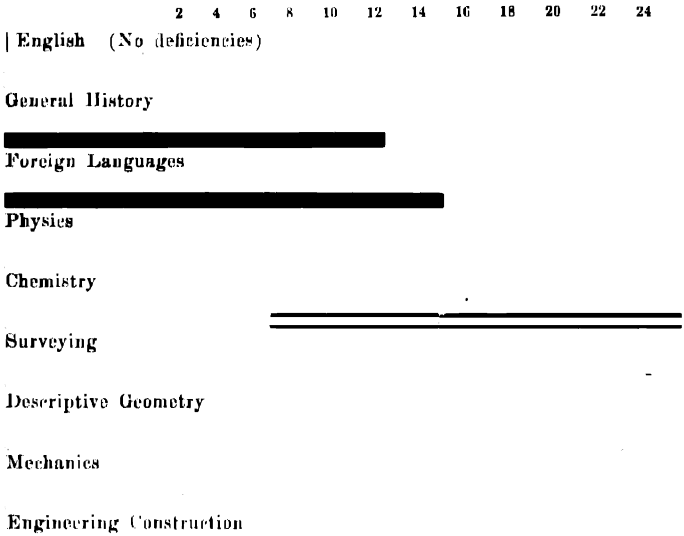
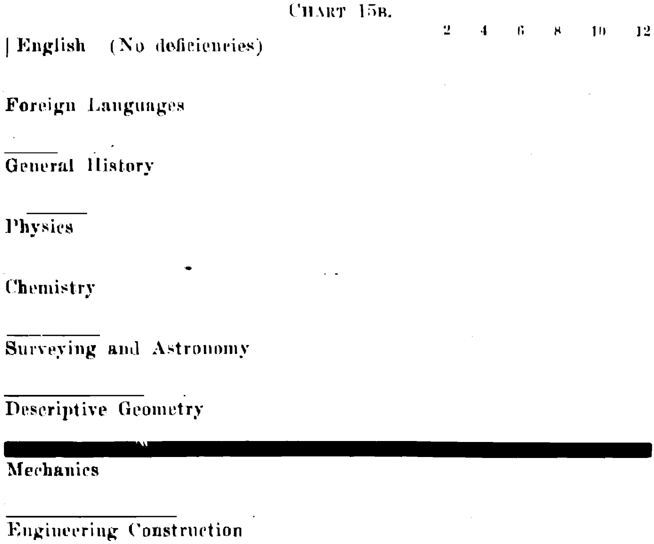


CHART 15B.



the percentages. Yet there does appear to be a strong reason for believing that the grade of the student, as shown in his training and experience, is improving. This is apparently brought out by Chart 12.

A study of the deficiencies is rather interesting. Charts 14A and 14B show the number and percentages of those who passed and received commissions providing they passed the physical tests. These percentages are rather small and while it was numerically possible for a man to receive an average of 80 and consequently pass his general average and, at the same time, receive below 67 per cent. in any one subject, yet of all these men who passed, not one was deficient. Charts 15A and 15B show a study of these deficiencies and also indicate in somewhat different form the general low grades in the several subjects mentioned above.

We have been studying now a circumscribed set of facts from which we are not permitted to draw general conclusions and apply them universally. However, we may say that in view of what we have, that the technical engineer coming up for his examination makes a fairly creditable showing. It must be remembered that those subjects in which there was a uniform low grade were subjects confined wholly to the curriculum of the technical school, and not those which a student would be apt to enrich by three or four years experience in actual work. The excellent showing in engineering construction, a subject which is learned better, perhaps, in actual practice than in classroom, bears out the truth of this. We were able to talk with an officer in the Engineer Corps who was competent to speak upon this matter and it was his belief that for ordinary engineering work men from the technical schools were lacking in application rather than in engineering ability and that at this time, to meet the needs of ordinary engineering work, there was no necessity at all for any great change in the ordinary engineering curriculum. What was needed, however, was a realization on the part of engineering schools of the general character of the engineering work, and a means by which engineering students looking for-

ward to national service in this war would be guided to select only those subjects which bore upon general engineering. This advice seems to coincide with the general experience of England for there engineering education has been changed only to admit into the curriculum those subjects which are concerned with new lines of military science. Under the present conditions, we may state that there is apparently no great adjustment necessary to meet the war need of the engineering profession.

Discussion.

F. H. Constant: The subject needs no formal opening. The diagnosis of the case of engineering colleges hardly needs to be stated to this body. Its symptoms and the pains connected therewith are a matter of experience to all of us. We have not, however, really discussed at length as yet any practical form of remedial action, and in order to bring this subject before the meeting so that we may exchange views and try to get at the wisest way to meet the situation, I shall briefly review the facts.

Early this spring the American colleges experienced a veritable stampede and, as was to be expected, the engineering departments suffered the most. The causes of this stampede were, first, a genuine desire on the part of the young men to enlist in a cause which they have espoused with greater and greater enthusiasm during the last two and one half years, but which became one of supreme appeal when our own country entered the war. That they were unselfish in this response is indicated by the fact that they went into all forms of service without thought of any particular honor connected therewith or of the opportunity for future promotion.

A second cause was the feeling on the part of many that if they could begin their intensive military training early, their chances for a commission would be correspondingly improved. There was also the fear that when the government finally passed the conscription law, they might be drafted as privates

unless they had already enlisted in some other chosen form of government service.

The momentum of this stampede reacted upon the remaining students who felt that they were more or less stigmatized as cripples or slackers. This stigma unfortunately still remains, and we shall have to face it this fall when we go back to our classrooms. Many young men will probably be loath to go back to a place containing, as they think, only cripples or poltroons.

A little later reactionary influences began to be felt. The public statement of men high in military authority such as General Black made here today, that young men can serve their country best by remaining in college, will probably bring back many in the fall.

Secondly, many have been disappointed by failing to receive commissions.

Thirdly, the parents are beginning to take a hand in this matter. To some extent they have resented the influences of the college which have swept their children away from them, and undoubtedly during the summer many will urge their boys to return to college.

What the effect of these various influences will be upon the attendance in the fall is very uncertain. I cannot but believe, however, that unless the colleges take some active measures to convince the young men of the wisdom of returning and completing their courses, and will reinforce this appeal by a wise adaptation of curricula to meet the present emergency, our upper classes will be much depleted this coming year.

The effect of this upon the college is, of course, relatively unimportant, but the effect upon our industries, both during the war and during the period of reconstruction after the war, is a matter of supreme importance. This, of course, I need not emphasize, because it has already been stated strongly here today. There is a genuine alarm on the part of manufacturers and employers of engineers, that the supply of mentally trained men will be cut off. They see the colleges, to use their own expression, "by-passed." They are forced to throw more

and more responsibility upon young shoulders, and they fear that soon they will have to entrust this responsibility not only to young men, but to young men of limited educational training.

How can the colleges remedy the situation? I think we all agree with General Black that exemption of students from conscription would be both unwise and unfortunate. But the colleges can speed up their educational processes. The engineering schools can intensify their work, not, perhaps, by increasing the number of subjects and class hours per week but by a more careful study of the efficiency of their methods. They can take advantage of the fact that selected groups of strong men always forge ahead much faster than the larger mixed classes.

There are also the summers, always a problem of considerable perplexity, which undoubtedly can be utilized for this purpose. Princeton is working upon a solution of the problem along these lines. It is proposed to accelerate the work so that students entering the freshman class this coming September will be graduated in three years instead of four years. There will be two summer terms of nine weeks each following the first and second years respectively. The number of class hours per week will not be changed, remaining about seventeen or eighteen, but some present loss during the term will be recovered in various ways, so that the number of weeks in the academic terms will be greater than at present. By this plan the actual number of class hours in the three-year course will amount to ninety-three per cent. of the number now given in the four-year course. We believe that the nominal per cent. loss will be easily made up by the better quality of the intensive work.

Of course, such a plan will not be at all workable unless the regular four-year course into which the weak or unwilling men can be placed is likewise maintained. Provision is also made for the earlier graduation of the present sophomores and juniors whereby the former, by taking in addition two summer terms, will graduate the August preceding the June in which

they would ordinarily graduate, and the juniors, by including the summer term of 1918, graduate in February of that year. The seniors will complete their course in the regular way. I have always felt that engineering education should be pursued in a more or less deliberate way, leaving time for a certain real coöperation between the college and the industrial world into which the student is soon to pass. The simplest way, administratively, is to encourage or require the students to spend the summer vacation in commercial engineering work. The plan here suggested is at the opposite pole. It intensifies the scholastic work. It gets the student out into the world and into the niche where he can most effectively serve his country in the shortest space of time. It must make its appeal to the patriotism of the stronger men who are willing to make the sacrifice. Of course, it is a war measure. Time is the important element at present and whether this or any other plan of education should be retained after the war will be determined by its measure of success. The colleges have an opportunity now of trying out several educational plans that would seem rather radical in normal times, and a very good excuse for dropping those that are not successful when the emergency is passed.

W. G. Raymond: Not until I came this morning did I have the remotest idea I was expected to say anything. I had been asked in a general way to speak, but not on any particular topic. Therefore, I did not come prepared to discuss this particular question. As I have not any preparation to discuss it, I find myself somewhat at a loss as to just how to begin. Perhaps I would better content myself with saying something of what we are doing. It is not very much; it is only a beginning; yet I can not help again reminding you that a good many years ago—so many years ago that I suspect a good many of you have forgotten it—Dr. Jackson and a lot of you jumped all over me for suggesting an all-year session. I am very much pleased to know, from what Dr. Constant says, that it is now being considered as a proper thing in time of war. I have not any doubt if he undertakes to put it

through in time of war, he will find it is a very proper thing to do in time of peace. In fact, I think he will hardly be able to go back to the old scheme.

We are fortunate at our institution in having military drill, the same as usually is prescribed at colleges of agriculture. At both institutions in our state we have military drill with a federal officer assigned. In our particular institution the boys in the college of liberal arts and the boys in the college of pharmacy and the boys in the college of applied science are all required to have this military training three times a week throughout the year. The boys in the college of applied science are organized into an engineering unit. We applied for an assignment of a unit under this reserve officers' training corps bill that was passed, and we were assigned an infantry unit. The matter of the engineering unit is still under consideration. Whether or not we secure that recognition from the government, we are still conducting an engineering unit. If you will excuse the personal allusion, my son, my baby boy, was the major this last year of that particular unit. He is now serving as a private in the training camp at Fort Snelling.

The work that was done by those boys was, I think, a very valuable training for them in connection with the service that they are now giving and the instructions they are now getting in the officers' training camp. I know also that the training those fellows get in the schools, although we had a most excellent officer in charge of our work, is not at all like what they are getting in the camps. That is a very much more strenuous job. What they are getting in the camps is the most intensive training that has ever been given in this country to young men preparing to be officers. A great many of them of course will be dropped.

By the way, just to show you the spirit that prevails, a letter from my son the other day spoke of the officer in charge of his company in most complimentary terms. He thinks his officer is the best in the whole camp, and he says that even if in the end he himself is dismissed and is not retained and com-

missioned, he will say "Thank you" for the good he has received up to this time. I have been in the camp myself, and I know the work that is done there is a most excellent training. The work we have done along this line at the university has been a most excellent preparation and has fitted our boys very well for this additional training that they are receiving at the training camp.

In addition to that, we have decided at last that it is desirable in our school to go to the small group instruction method. During the last three weeks I have employed all the time I could spare—and it has not been an easy job—to make a program into which our work will fit on the basis of three grades of men, a grade of men that will do the work in normal time or what we consider now to be normal time, a grade of men that will do the work twenty-five per cent. quicker and finish in three years, and a grade of men that will do the work twenty-five per cent. slower and finish in five years. I have laid out our work in a program which provides for those three grades of men, and also provides for some men that will be somewhere in between. I find that it can be done without question. I find moreover that what has been charged against it is probably not true, namely, that it will cost more than the ordinary method of instruction. So far as I have figured it up, it is going to cost a little less—not any more, but a little less in point of salaries, etc., and it takes no more space than we are now using. This plan will provide for the quick man, for the normal man, or what we consider to be the normal man, and for the slow man who is slow but sure. We do not propose to keep men if they are slow because they are lazy. Nearly half our men are in whole or in part self-supporting, and this slow-going section will provide for those men who must support themselves to a considerable extent through college. In that respect we are in the West a little different from the schools of the East.

So it seems to me the thing we can do best, those of you who have not already military training in your schools, is to introduce it; and, second, as Dr. Constant suggested, speed up our

work so we can graduate men, not with less training than they now have, but with as much as they now have, giving them more intensive work and helping them to get through in three years.

You will perhaps remember that we tried this out in our school a little a few years ago, and we found that at least some men, after carrying the work only two years and then being placed with the regular classes, were able to graduate in three years. One man who did this graduated at the head of the class and won the prize for the best graduating thesis. He is now recommended for captain's commission in the engineer corps. He has been a very successful man in business since he graduated.

I think I have said all I can at this time, and I thank you.

C. R. Mann: We have just heard two interesting definitions of engineering and the demands made on engineering at the present time. General Black said that the engineer is the man who, when he is told to do a certain thing, goes out and does it, whether he has the facilities with which to do it or not. We have also been told that production is one essential element in this war, and that it is the engineer's function to control production. Dr. Constant has suggested that the greatest service the engineering school can now render is to accelerate the process of developing the engineer,—not to develop a less competent engineer or a less well trained engineer, but to accelerate the process and make him better able to go out and do what he is told to do when the facilities are not there, and better able to guide, accelerate and increase our powers of production.

While this problem seems to be two problems, it is really one. That is, the problem of developing initiative, originality and the ability to handle a situation promptly even though you have not the facilities, and the problem of developing ability to control production are really the same. For what are the practices in engineering schools that hamper the development of these two factors, initiative and ability to produce? I would suggest, simply ex cathedra, if you like, without any

argument, that the first important obstacle to the development of these two things is the fact that in most engineering schools the freshman sees very little that looks like engineering. Almost universally the freshman takes mathematics, English, one foreign language and drawing. Of these drawing is the only thing that resembles engineering. In many of the engineering schools even in the second year the student still meets with nothing that closely resembles engineering. The idea is to lay theoretical foundations first and then teach him practice. I would like to raise the question for discussion here whether the students would not learn their engineering very much more quickly and more efficiently, and so be better able to accelerate production and exercise initiative in handling new problems, if we would correlate the work in the freshman year with some engineering work. Why not introduce into the freshman year a course which might be called "elements of engineering," which might deal with real problems in mechanics perhaps, or in the transmission of energy by machinery, in short with any kind of engineering problems that were real, concrete, definite and closely connected with his mathematics and his drawing, so that the three would be three phases of the same thing? Would not the students learn their engineering more quickly on that basis? Would they not acquire initiative more readily, and would they not be better able to aid in production?

I know of two experiments that are being made to test this particular question. The first of them you may have noticed last month in the bulletin of the Society is being carried out at the University of Washington in the teaching of mechanics. There they transferred the mechanics course from the third year to the first year, and gave it as a series of engineering problems in production. A sample problem, for instance, is "Here is a given dam; here are the conditions under which it is built; here is a description of the way it is built. Is the dam safe?" The student is required to find out. The problems given to the freshman involve the use of calculus methods in the solution. These methods are not taught beforehand,

but are taught when they are needed; and the result of the work is heartily gratifying to the instructor. The result is not, however, convincing to the rest of us for the reason that it is not measured by objective tests. Yet the experiment is suggestive of a line of action which may lead to more rapid development of engineers who have initiative and who can accelerate production.

The second experiment has not yet been made. It is planned for next year at Brown University. There a new course in engineering is announced with eighteen credit points per year. In the first two years three of those credit points are devoted to "applications of engineering" or "elements of engineering," consisting of practical problems well coördinated with the mathematics and drawing of the freshman year. Brown is thus going to try the experiment of teaching practical applications right along with the theory and closely correlated with it.

Hence perhaps this is the most promising method for speeding up the engineering education. Another advantage of this plan lies in the fact that a student who can stay only one or two years at an engineering school secures not only the theoretical training of the first two years, but also a certain amount of practical knowledge in handling things along with it. I would like, then, to suggest as a topic for discussion, the question whether the introduction of more engineering work into the first two years is not the most effective way of developing initiative and speeding up the training of men for intelligent production.

G. C. Anthony: I will say just a word concerning the courses that we have been trying out at Tufts. As yet I really do not know very much about the results, but they appear to have been good. We have gone some way toward carrying out that work which Dr. Mann has suggested, but mostly during the sophomore year. In the freshman year we have introduced surveying, and already give courses in mechanic arts and drawing. In the sophomore year we give the first course in electricity which is a comprehensive survey of the subject.

We have also introduced a course in heat engineering, which is closely correlated with one in mechanism. We also begin hydraulic engineering in the sophomore year, a course which has proved to be rather severe, yet one of the popular courses. We are giving five distinct engineering courses, and introduce the beginnings of them all in the sophomore year, since we allow no differentiation during the first two years, nor do we allow any differentiation between mechanical and electrical engineering until the senior year. The real work in mechanics is not begun until the sophomore year, but I have been very much interested in the work that has been described here as carried on at the University of Washington. I am, nevertheless, a little suspicious of the results that might be accomplished elsewhere but, of course, it depends very largely upon the teacher. Under proper conditions almost any subject can be taught in any year.

One change that has been necessitated by our new curriculum is a postponement of advanced mathematics. We are discontinuing mathematics at the middle of the sophomore year and do not propose to continue it until the middle of the junior year, at which time we hope there will be a keener appreciation for the subject, when we can correlate it with more advanced work in applied engineering. The result of this change remains to be seen.

C. E. Magnusson: I wish merely to add that as a direct result of Professor More's methods of teaching mechanics (described in the May, 1917, Engineering Education, by Mr. Duckering) the revised curricula for all our engineering students require three hours per week in applied mathematics during the freshman year. The work consists of engineering problems as mentioned by Dr. Mann and is presented from the engineer's point of view. We hope to give the students an introduction to the work of the profession he intends to enter and also to increase his interest in mathematics and physics.

A. A. Potter: We are all interested in the intensifying of

engineering courses to meet the present emergency. I would like to find out a little more from Dean Raymond as to how this method works and if it does not affect the standards. The question to my mind is, what methods do you use for continuing the course during the summer months? Is Dean Raymond expecting teachers to teach classes eleven months in the year?

Dean Raymond: The plan we have had contemplated only nine months' work.

Dean Potter: Let us assume that you have students in the senior mechanical engineering class, taking a course in heating and ventilation Do you have three sections and are your teachers expected to teach such additional sections?

Dean Raymond: We might have to have three sections, and we might not. That is all a matter of making up the program. If you will see my chart, you will perhaps be able to understand it.

Dean Potter: How do you expect to handle them without increasing the load upon the teachers or without increasing the budget? It seems to me you have to increase something. Your teachers must handle more classes per week, or you increase the number of teachers.

Dean Raymond: It is merely extreme familiarity with the subject on the part of the teacher.

Dean Potter: But we are interested in having pointed out how you do it.

Dean Raymond: I can not possibly explain it here in a few moments. If you will see me personally, I shall be very glad to explain it to you or to anyone else who may be interested.

Dean Potter: I think it would be worth while for Dean Raymond to prepare a paper for publication in the BULLETIN of the Society which would set forth his method of handling the situation without increasing the budget.

Commander W. T. Cluverius, U. S. N. (U. S. Naval Academy): Mr. President, apropos of this particular subject relative to speeding up engineering curricula at all of

our institutions, that necessity has, of course, been forced on us at Annapolis. We have graduated this year two classes of nearly two hundred each within three months of each other, and one with practically only a three years' course. We know that there has been loss of professional instruction and at a vital point in the course. The demand for officers had to be met. The manner in which we realized some additional time in this emergency may be of interest.

We look at the situation from the armed-force viewpoint, but it has much in common with the utilization of engineering graduates of civil life in the national service, one of the present questions now under discussion here. When the word came to graduate the classes ahead of time, we at once abolished the review months which ordinarily precede the term examination and also the examinations themselves. We gained thus two and one half academic months, of four weeks each. In addition the class which succeeded to first one for early graduation was retained at Annapolis instead of being sent to sea on the usual three months' practice cruise beginning in June of each year. This, however, did not net us much time as a subsequent order came by telephone from Washington to graduate that class the end of June instead of in September. They went. I will not say that they were completely equipped in engineering but they are getting the rest of the course by experience right now. Monthly examinations are held, the weight of which is one third of the recitation marks, and midshipmen are required to be satisfactory each month. The Engineer Corps of the Navy, as such, was abolished in 1899. Since that time every graduate of Annapolis is required to qualify in engineering and begins his work upon entrance and continues it until graduation. As a matter of fact, the class now entering and which will number nearly 800 when the Naval Academy begins its next regular year in September is already at work in the shops of the Department of Marine Engineering and Naval Construction and receiving practical instruction in the operation of

power boats. It is a problem of course, but solved—for us—when the order comes to go.

In regard to a matter which I feel to be most important and which I believe to be closely associated with these discussions —I refer to the training of engineers who are shortly to be required in vast numbers for the merchant marine service. We have been talking of the enormous amounts of material being assembled for use on the other side; in fact, already going across; of the vast number of men and officers who are to go to the front in a war which will last for years. We must consider the greatly expanded shipping which this country is building and buying in order that this material and these troops may be transported across the Atlantic. The matter is not yet receiving enough attention. Marine engineers are to be required greatly in excess of the present supply. A number of small schools along the seaboard have been started with a view of giving additional instruction to men, locally, best fitted to go into that service. There will soon be demands in many directions for personnel of the sort in the government-owned vessels now building and the transports being secured. Only this morning, the Coast Guard advertises for engineers of all classes without regard to license.

There are a number of colleges belonging to this Society which maintain courses in mechanical engineering and many in marine engineering. It is a pertinent question to ask if these schools should not adapt and popularize their courses, in this time of war, to meet the needs of education of thousands of young men who are to be required at the throttles of thousands of merchantmen. How better can we get them? It is a practical education they need. The type of men to be recruited for the merchant service could not possibly pursue the courses these institutions now maintain. It is not necessary that they should. Scores of schools—technical colleges and intermediate engineering schools, trade schools—at Boston, New York, elsewhere, inland as well, have available resources to train these people,—not in the theory of thermo-

dynamics or in engineering descriptive geometry, but in the practical operation of a reciprocating engine, of a water tube boiler, of turbine machinery. The additions to existing elementary courses can readily be determined—that part of it is not a problem.

In so far as the Navy itself is concerned, we are taking care of our end. Our increased enlisted engineering force is being trained in the battle fleet. Of the several thousand reserve officers, enrolled from civil life, two hundred were sent to Annapolis yesterday—selected from every naval district—to get an adapted course. Many are graduates of your institutions. They have settled down to a two months' intensive job. Their day begins at 6:20 in the morning and ends at 10 at night. We will try to perfect them as best we may in this time. These men will go into our ships both on deck and below. We believe that the Navy has a practical way of dealing with the question of how shall the graduates of engineering schools best serve their country in time of war. These men will go into our fleet and our patrol on this side—and on the other.

But we want the convoy to get there, too, with its all-essential cargo. The engineer is needed to do this. Our institutions can render a practical service first-hand to the national government in providing him, and the Navy will certainly welcome the help.

K. G. Matheson: I want to depart for a moment from the topic under discussion, to bring the attention of the Society to a matter which appeals to us from a practical standpoint at the Georgia School of Technology.

We here on all sides great emphasis being laid on the desirability and absolute necessity of retaining men in the colleges, and in particular in the engineering schools. That has been emphasized by the President of the United States, by General Leonard Wood, by the Department of Education, and by other high officials. And yet, when the question is asked General Black this afternoon how the men ought to be retained in the colleges, at once the idea is advanced which

already holds in the colleges, that we have to be very careful about this or the college will be regarded as a bombproof for slackers. Gentlemen, how are we going to solve this problem? We are told with great emphasis that it is absolutely necessary to have men remain in the colleges, and yet on the other hand we are told if we try to keep them there, there is danger of having the college regarded as a bombproof for slackers. It seems to me that one solution of the problem is this, that we can have this Society pass a resolution favoring the retention in the engineering colleges of students for their senior work.

I wish to state this, gentlemen; This doubtless is the experience of every engineering college in the country. At the Georgia School of Technology—this is a concrete illustration with which I am entirely familiar—we are receiving applications, sometimes as many as twenty-five in a day, for the services of the graduates of that institution, without having a man available. Of our senior class of one hundred men who graduated on June 14, sixty-five per cent. went into training camp at Fort McPherson. Over two hundred of our men are there. Eighty-two of our men are in the coast artillery training camp; and so it goes. There is an enormous demand for the services of the engineer in the industrial development which is directly concerned in the proper conduct of this war, without any men practically to meet the demand. Of the senior class of next year, of about one hundred and twenty or one hundred and twenty-five men, I am informed that over half of these men have been spoken for, or at least that they are thinking of going out into service of various concerns without remaining in the college and getting their degrees, and thereby greatly increasing their efficiency. The reason is just the reason that General Black expressed this afternoon, that if they remain in the colleges they will be rather looked down upon. If it is essential that these men should be there, should not there be a note of authority which will enable us to retain them in the colleges? We are perfectly willing to do whatever the country wishes us to do—if necessary, close the doors of the colleges and let the men go out, but we know from the

experience of Great Britain how very unwise that would be. We realize that she realizes that she made the mistake necessarily which will be for a very permanent hurt, and which we wish to avoid. Would it be possible to pass a resolution, advising the young men in rising senior classes, to remain in the colleges until graduation and then to accelerate the other classes?

We have established at Georgia Tech military aëronautics for a course of intensive training, and we have evolved some idea of how we can accelerate this course so that the men in the rising junior class need not take two years for graduation, but may graduate at least within a year and a half. Something has to be done, and that immediately. It the impression is allowed to prevail that is wrong for these men to stay in the colleges, we are going to have exactly the same experience which Great Britain had to her permanent hurt. It seems to me that one of the most practical questions this Society has to perform now is to take some action—you will have to take into consideration of course what we can do—about the retention of these men in college until their graduation.

J. F. Hayford: I would like to do my part in focusing the remainder of the discussion along general lines of the talk that has just ended. It seems to me that we are faced by a condition rather than a theory in two respects. We are faced by this condition that at the same time that we have an exodus of engineering students from engineering colleges, we have a greatly increased demand for graduates in engineering. That is one of the conditions that faces us which forces us to act in a different way from which theory might impel us to act.

Another way in which we are faced by condition rather than theory: It certainly is a good theory that in our attempt to hold the students of engineering in the colleges of engineering; we ought to be enthusiastically backed up by the authorities at Washington. The condition is that there are extreme complications in the situation at Washington, and on the face of it we are not getting the backing we should have. In reality, possibly we are. Remember now that I feel that we

are facing a condition rather than a theory in these respects, and so if you find the resolution which I am about to offer is a good deal more mild than my belief, remember that I believe we are facing a condition which we ought to recognize, and therefore, we should try to do the thing we can do rather than to try to do the thing we ought to do, but can not.

It seems to me that exemption for students of engineering is an impossibility. The time for that kind of action is probably past for exemption as such. I believe, however, that the law leaves a large discretion and power in the hands of the President of the United States. I hope the resolution which I am about to offer will explain the rest of my mental attitude. I would like to offer this as a resolution intended to focus discussion and to bring action, if my guess is true that on this part of the matter at least, we all think alike. I offer this as the resolution:

"*Resolved*, That a comittee of three be appointed by the President of this Society to prepare a resolution addressed to the President of the United States, expressing the opinion of this Society that it is desirable that students of engineering should complete their college courses, and that it is desirable that such engineering students as are necessarily drafted into military service be placed in positions in which they may render the best service of which they are capable."

It seems to me such a resolution should, within the limits of the resolution, state briefly the basis of the opinion of the Society, and that this resolution, if prepared in this way, should be reported back to the Society before the end of this meeting, so that it may be forwarded to the President. Notice in a general way I am trying to focus the opinion of the Society where I believe it will do the most good. It is a well-known principle among men who have had much experience in coming to Washington to get things done, that if you are in doubt how high up you go in the organization, resolve all your doubts in going as high as you can. That is the basis of my belief that we ought to address this resolution to the President

of the United States. I, therefore, move the adoption of this resolution which I have just offered.

F. C. Caldwell: I am glad that the discussion has taken the turn that it has. It seems to me that the great problem before the engineering teachers of the present time is this problem of supplying engineers. We had about four times as many applications for graduates before the war began as we had men available, nor was this peculiar to us. The situation is the same throughout the country. That is a pretty serious condition. On top of that, comes all the demand which must follow from the war, both direct and indirect. We are faced with a most difficult problem. Obviously one aspect of that problem is this matter of keeping the students in college. Ohio State has been in pretty close touch with the war department. We have several in our faculty who have been very active. Yet we have lost very few of our engineering students so far through voluntary enlistment. I think there is very little of the feeling that a man is ashamed if he does not immediately enlist. This has been due to the same attitude taken by those who were most interested in the military situation.

The other aspect which is directly in line. I think, with the resolution, is this: Some students are going to be drafted, and the question then comes as to whether they will be allowed to take the course of the draft and go into the trenches as privates, or whether something else can be done. I was told recently by an officer of one of the medical colleges that it was the hope there that the draft would be suspended in the case of medical students pending completion of their course—not that they will be exempted, but simply that the draft will be held up till they have completed their medical preparation, or at least until the need for their services becomes pressing. I do not know whether anything of that sort can be carried out, but it seems to me that is a thing which we might well hope to see done with the engineers, especially if it is being considered for the medical students.

Dugald C. Jackson: The reason I wish to speak to this point is the fact that there seems to me some disagreement as to the

objection to be accomplished. I will not of course at the present time undertake to go into the old style rough-and-tumble scrap with Dean Raymond which we formerly enjoyed so much. He has misconstrued some of our old times. I had some notes on Professor Constant's remarks. I think Professor Constant's suggestions are ideas which would lead us to the sort of resolution that is before us. I am glad, therefore, to hear the proposal contained in the resolution.

I also rose to my feet in regard to the suggestion of someone here that a statement from the President of the United States to the students of the engineering schools, that they should stay at their studies, would keep them there. I do not believe it, unless it is at the same time pointed out to them that it is their duty, and the reason why it is their duty. The students of the engineering schools of the United States are young men of a great deal of enthusiasm, a great deal of hard sense, still youthful to be sure, but of high ideals; and a mere statement (even if from the President of the United States) that it is better for them to stay in the leading strings of the engineering schools will not keep them there if they think it is their duty to go to France. We need something more than has been suggested, and we also want something to go into the minds of the students that is distinctly different from the simple suggestion just made that we professors would like to have the students remain in the engineering schools. That sounds as if the professors want the engineering students at the engineering schools so that we may have occupation next winter. Of course, that interpretation is ridiculous. If we want the students in the engineering schools next winter, it is because we believe it is for the best interests of the country. There can not be any other reason in the minds of the real teachers of engineering, and I do not think there are any others here. We believe it is for the best interests of the country for the engineering students to complete their studies, and therefore that it is their duty to complete them if they have the opportunity, and the situation needs to be brought to the minds of our students from that standpoint.

As far as exemption from the draft is concerned, I am not at all impressed by the remarks that have been made. I have looked at this matter for months from three standpoints. One is from the standpoint of my students, who are quite numerous. Another is from the standpoint of a very large staff in the department that I have the great honor of having to do with, from which about one third have gone to the service of the United States already. And the third standpoint is from that of my own family, a family of two children, with only one son. My son has gone into the service although only through the equivalent of the first two years of his engineering course. Perhaps if the young man and I had conferred together today, instead of three or four months ago, I might have undertaken to pursuade him to go on with his engineering course; and yet, on thinking that over, I think of the enthusiasm of youth, the enthusiasm for ideals of righteousness and civilization and the high feeling of youth that it is necessary for the ablest young men to go and do their duty if they can, preferably as officers, and to get the education to become officers—and if they can not get this education, to go anyhow—with those ideas in mind I have doubts whether I should have tried to change the course of the youth, although I recognize that in my family and innumerable other familes the chances of unspeakable grief through this war are tremendous.

Since our students have well-developed ideals, ambitions, and views of what is right, and their enterprise and enthusiasm are so great, they will embrace immediate activities in the war and leave the engineering schools unless we can show them convincingly that it is in the direction of a proper development of their enthusiasm and ideals for them to stay with us until their studies are completed. If we can do that, I believe we will have helped to solve the present unhappy situation in which there appearently will be a continuing call for trained young men in the war.

Director Hayford's proposal seems to me aimed in the direction of these views. For that reason I favor it. I believe the engineering students should preferably stay with us to

complete their studies, and I believe they largely will. Some will be drafted, but the young gman who is drafted is not disgraced. He is called by the nation, in a sense, although it is by lottery, and the young man in the engineering school who is a junior and who has been well trained up to that point and is drafted, will soon be an officer, and it will not be to his discredit to have obtained a commission by the way of the ranks instead of going in originally as an officer. No young man need worry about the draft. It is an honor, and not otherwise. A few of our students will be drafted, and let us do our best to show the rest of them that it is their duty to complete their studies, and that their best ambitions and best ideals and best enthusiasms should bring them back to us for as long as is necessary to their useful education. In connection with their engineering instruction, let us put in the proper amount of special military instruction, if we can possibly get the men to teach it, so that these young chaps will be ready to be most useful in either the war or civil life as soon as they graduate. If we do that, we will have settled our problem wisely. We have the opportunity to do it, but let us not try to do it by mere resolution. Let us make it a matter of convincing presentation which will appeal to our students.

G. F. Swain: In common with many other members of this Society, the idea had come to my mind that we ought to pass some form of resolution to bring to the minds of our students the fact that there are other fields in which they can be useful rather than in the trenches. I am very glad indeed to support the resolution offered by Dr. Hayford. However, before referring this matter to a committee as he has suggested, I would like to amend his resolution by omitting the words "addressed to the President of the United States." I see no reason why we should pass a resolution to be addressed simply to the President. A copy should be sent to the President, and to other government officials, and the resolution published in our transactions so that our students and professors can all see it. I offer that suggestion as an amendment, and move its adoption.

(The amendment was seconded and carried.)

D. C. Humphreys: I am very much opposed to petitioning the President of the United States. The President has said all we could desire him to say or expect him to say. I am in favor of expressing as the opinion of this Society that the students in the engineering classes should stay at college, especially if they are under age. I am very much opposed to having this Society ask any exemption from the draft for men twenty-one years of age and over. It looks too much like "It is interfering with our business, and when you come to touch me, I want you to let my business alone." I do not see any reason why college men twenty-one years old should not go. The mere fact a man is in college shows he does not have to earn a living for anyone. The money paid to send him to college can be spent in helping people along that are dependent. In other words, he is free to go. As a rule he is unmarried, and if he should not go, who should? That comes up to my own family. One boy twenty years old was anxious to go. I said to him that the beauty of this draft is that Congress has decided that it will designate whose duty it is to go. That is the idea. It is every man's duty to give his life to his country if called on. It is the duty of Congress to pick out the men who shall go. I said: "Congress has designated the men between twenty-one and thirty years of age. It has not told you to go. You are in college and the President says you ought to stay in college." The Commissioner of Education said so too and the Chief of Engineers has said so just to-day. I talked to him in that way. He said: "If they think it is my duty to stay here, I will stay here another year." Another one in the family was twenty-one years old, and he attempted to volunteer in the ambulance corps that was sent off, because he thought it was a sort of odium to be drafted. We persuaded him out of that, and he is now in the place that was designated for him and is in training to go where he is told to go. That is the position every young man ought to have in a republic. I am opposed to asking the President to excuse our boys if they should happen to be drafted.

Anson Marston: I believe that we ought not to ask for any exemption from the draft for engineering students. It becomes a personal matter with each of us. I have a boy twenty-one years old, and he has entered the training corps. If he does not secure a commission, he will enlist, and if he did not I would be ashamed of him. That is the situation, though I do not know whether he will come back from the war alive or not. Although I do not think that we ought to ask any exemption for engineering students, I do think that the Government should use them when drafted in such capacity as to get the benefit of their engineering training. I am in sympathy with that portion of the motion, and for that reason shall support the resolution.

C. H. Crouch: I feel as Dean Marston does and as the preceding speaker does with reference to asking that engineering students be exempted from the draft. As I understood the resolution, there was some word just before the word "drafted" that sent a chill through me. I think that word implied that we thought perhaps the engineering students ought not to be drafted. My idea is that I do not care who the student is, whether a liberal arts or an engineer or not, he should take his chance along with the rest of them. The fact that he is an engineering student should not give him exemption, and I for one would like to see that word dropped.

J. F. Hayford: The word to which you refer is, "that it is desirable that such engineering students as are *necessarily* drafted into the military service be placed in positions in which they may render the best service of which they are capable." I have no objection to throwing out the word "necessarily" if the Society wishes. If they are drafted, it will be because it is necessary.

Professor Crouch: It seems to me that word in unnecessary, and it sent a chill through my system. I move that the word be dropped.

Professor Jackson: The present draft is for five hundred thousand or more troops. We will have additional drafts. This resolution which is now being proposed is not pointed directly at the first draft, but it will have to be directed at several,

because we so not have another meeting of this Society for twelve months, and it does seem to me word "necessarily" is perfectly appropriate because there may come an additional draft in later months, after some further consideration of the appropriateness of carrying on the educational institutions in their present capacity has been made by the national authorities, and I believe the word "necessarily" or some similar word is not at all objectionable.

Dean Marston: I was very much interested in the account by Professor Constant of his plans for engineering work in summer schools, and I am anxious to know how many institutions are making similar plans. I would like to ask if the chairman could not obtain an expression as to how many schools are preparing to speed up the summed work?

C. R. Jones: Dean Marston has asked for an expression from those who come from engineering colleges, that are offering or contemplating courses during the summer. Previous to the action of the college presidents at their recent meeting at Washington, our students were in a state of turmoil. When word came back that they could serve their country perhaps best by remaining in school, there came a demand for an accelerated course. There was a joint meeting held between the students and the faculty, and it was agreed at that time to have a continuous session during the summer. I appointed a committee composed of the heads of departments to look into the question. After we studied the matter thoroughly, it seemed to be unwise to keep the freshmen and sophomores in school continuously; but we did make arrangements to have a continuous session for the junior class of last year, which is now the senior class. The class will not be given their degrees until June, but they will finish their courses in January provided they go into some useful line of work for the remainder of the year. Those who go into the army as well as those that go into the active engineering work will be given their degrees next June. All we are sacrificing, I believe, is the theses and one elective study. It is an experiment and of course we do not know how it will come out. Up to this time the students have done excellent work.

CERTAIN RELATIONS OF A COLLEGE OR UNIVERSITY TO THE ENGINEERING DIVISIONS OF THE MUNICIPAL SERVICE.

BY ARTHUR H. BLANCHARD,

Professor of Highway Engineering, Columbia University.

The opportunities of institutions with well manned and thoroughly equipped engineering departments to be of service to municipalities are many and varied. While not presupposing that the following suggestions cover the entire field of service which might be rendered, the concrete recommendations will serve to illustrate the nature of the relationships which are practicable.

In order to be of maximum service the functional activities of the institution should comply with certain fundamental principles.

First, the institution must be administered by a president, trustees and deans sufficiently broad-minded to allow of the efficient use of its faculty and equipment in the service of municipalities.

Second, maturity, earnestness of purpose and ability to meet essential requirements should be the criterion upon which is based the utilization of the institution's facilities by members of the engineering department of a municipality and other citizens of the municipality and nearby localities who are interested in engineering work.

Third, the maintenance of a professional status which would place the rendering of consulting service by members of the engineering faculty and the conduct of laboratory tests and investigations upon the same financial basis as adopted by private practitioners.

A summary of the fields of coöperation in connection with

which institutions may render service to the engineering divisions of municipalities includes the following:

1. Day and night courses covering subjects of value and interest to members of the engineering division.

2. Consulting services, by members of the faculty, to the various departments of the municipality.

3. Membership of members of the engineering faculty on public service committees and commissions, and in local associations.

4. Investigations and tests for the municipality conducted in the laboratories of the institution.

5. Series of lectures in the various branches of engineering delivered by specialists.

6. The efficient utilization of the libraries of an institution by members of the municipal service.

Night and Day Courses for Municipal Employees.—In order that courses given by institutions in the interest of engineering departments of municipalities should be successful, certain fundamental principles must be recognized.

First, courses must be given for which there is a demand.

Second, the courses must be conducted by men capable of efficiently instructing municipal employees and who have a reputation and experience of such a character as will attract members of the engineering division of a municipality. For example, an instructor might successfully give a course in mechanical drawing, while, on the other hand, a professor, with extended experience in practice, should give such courses as power plant design, highway engineering, water supply, etc.

Third, courses must be given at such times and in such periods as will render practicable the taking of courses by the maximum number of municipal employees. For example, night courses should be given in periods of from two to three hours on one or two evenings per week during the late fall, winter and early spring. Day courses should be given in concentrated periods of not more than two to three weeks in length, the lectures and laboratory work requiring, on every

week day, from two to eight hours per day, depending upon the character of the course. Day courses likewise should be given in those periods of the year in which it is practicable for municipal employees to secure leaves of absence or vacations.

Fourth, the requirements for entrance on courses should be maturity, which has been defined in certain cases as graduation from high school and being over twenty-one years of age, and ability to meet the educational prerequisites of the course which the applicant desires to take.

Fifth, fees should be as low as practicable but should cover the cost of giving the course, except in cases where public spirited citizens, interested in the development of the maximum efficiency of municipal employees, donate funds to cover the expenses of giving such courses. In the latter case it is advisable to charge a nominal fee of from five to ten dollars, dependent upon the character and length of the course, in order to limit the attendance to students of serious purpose. Members of the faculty should be paid for giving such courses in addition to salaries received for regular institutional instruction.

Consulting Work by Members of the Faculty.—Many opportunities exist in municipalities for members of the teaching staff to establish professional relationships with municipal engineering departments which will result in mutual benefit to the municipality, the institution and members of the faculty. Generally speaking, this work should be in the nature of consulting services, which may be temporary or on a yearly retaining basis. Charges for such work should be not less than for regular professional services, ranging from fifty to one hundred dollars per day.

Membership of Members of the Engineering Faculty on Public Service Committees and Commissions, and in Local Associations.—In most municipalities opportunities exist for the rendering of public service, without remuneration, as members of committees or commissions appointed by the mayor, or some other public official, or which may have been

organized by a group of citizens interested in some form of public improvement. Also there may exist engineering associations or local bodies, such as chambers of commerce, whose work may be materially benefited by the advice of members of the engineering faculty. In the interest of the general uplift work in a community and the efficient administration of public works, membership should be accepted and, as far as practicable, enthusiastic service should be rendered. It has been the writer's experience that the plans of municipal officials and legislative bodies have been materially effected and, in some cases, directed by resolutions emanating from local committees and associations.

Investigations and Tests for Municipalities Conducted in the Laboratories of Institutions.—A field of coöperative service exists, in connection with laboratory investigations and tests, which should be developed to the fullest extent. It is practicable, in many cases, to work out an arrangement which is efficient and economical both for the institution and the municipality. In most cities, due to the fact that investigations and tests are not called for in amounts requiring the continuous service of a laboratory, costs of investigations and tests to the municipality in all probability will be lower if done in an institution than if a laboratory was maintained and operated by the municipality. Furthermore the municipality saves the capital investment. Based on an extended experience with this kind of work, it is believed that the following factors are essential to an amicable arrangement between the laboratory and the municipality.

First, the work must be conducted in accordance with the standards and methods adopted by the municipality.

Second, the work must not be done by inexperienced undergraduates or by seniors, as thesis work, but the detailed work of investigations and test must be handled by trained laboratory assistants under the general direction of an engineer of considerable experience in practice.

Third, the name of the institution should not appear in the transaction but it should be made through the medium of the

engineer in charge of the laboratory. The engineer should contract, independent of the institution, for investigations and tests, should receive all fees for such work, and pay all expenses of conducting the work, including charges by the institution for the use of the laboratory and its equipment. This arrangement is advocated because several institutions have been unfavorably brought into the public eye through the medium of litigations in connection with which investigations and tests made in the laboratories of the institutions have been quoted.

Series of Engineering Lectures.—The rendering of material educational assistance to the community may be accomplished through the medium of lectures open to the public. These lectures may form a part of some of the regular educational programs of the institution or may be given specifically as a part of an educational campaign in the interest of the citizens of the municipality. Such lectures should be given by recognized specialists either in the employ of the institution or who are brought to the institution from outside sources. At first glance, the proposition to admit the public to lectures on special engineering subjects which form a part of the curriculum may be open to serious objection. Based on an experience of over five years in connection with this detail, the writer wishes to state emphatically that the advantages accruing from the admission of engineers and others who may be interested in the subject of the lecture far outweigh any apparent disadvantages. For example, in connection with the graduate course in highway engineering at Columbia University, from twenty to twenty-five lectures by recognized specialists were given each year. Notices of these lectures were mailed to all engineers and others in the city and nearby localities who might be interested. Attendance at such lectures was required of highway engineering students enrolled in courses in connection with which the lectures were given. At the conclusion of each lecture opportunity was given for a full discussion of the subject presented. These discussions were participated in by the highway engineering

students and by engineers, chemists and others from the outside. It is obvious that the students of the institution materially benefited by the discussions of outsiders who, in many cases, were specialists in the subject. The lectures heretofore mentioned have been on subjects in special fields of engineering. From time to time, however, the institution may do valuable work by conducting a series of popular lectures on engineering subjects primarily designed to give the public information relative to the scope of each field of engineering and works of magnitude and importance which have been accomplished in each branch.

The Efficient Utilization of Engineering Libraries.—The libraries of engineering departments of an institution should be thrown open to the public under such regulations as the necessities of each department or institution dictate. An investigation of technical libraries made at the time of the establishment of the Davis Library of Highway Engineering, now maintained by the National Highways Association at Columbia University, indicated that few engineering libraries were conducted efficiently. It is admitted that, in some cases, inefficiency is due primarily to lack of sufficient funds for proper upkeep. But in many cases practicable methods of fully utilizing the resources of a library are either not known or their value is not recognized. An individual seeking information in a definite field of engineering in entering most libraries is in the position of the searcher for the proverbial needle in the haystack. In most cases he is turned loose in the Dewey classification of literature which is not adapted to the needs of an engineering library. In the conduct of an engineering library for the use of engineering students, as well as the public, numerous classifications and indexes of the contents of the library are essential. In the Davis Library of Highway Engineering, for example, it has been found that to properly place at the disposal of users the large mass of literature in the form of monographs, reports, specifications, etc., three indexes are necessary, namely, an author index, a title index, and a subject index. In the case of the highway

engineering literature contained in eighty periodicals, currently received, a subject index has proved satisfactory. In addition to the classes of literature already mentioned and books covering engineering and related subjects, an engineering library should contain a series of files of catalogues of materials and equipment used in the branches of engineering covered by the library. In the Davis Library of Highway Engineering these files have proved of inestimable value to engineers, chemists and contractors. It has been the endeavor to include catalogues of all materials and equipment used in highway work which are manufactured in America, Great Britain, France and Germany. The contents of these files is made available through two indexes. One, an index of the names of the companies; the other, a subject index, consisting of a card or series of cards containing the names of all companies manufacturing a given material or piece of equipment. A library rule of procedure, which has worked out satisfactorily in the Davis Library and has proved of material assistance to users of the library, is as follows: A newcomer is taken in charge by an assistant librarian who explains the several indexes and the methods of conducting research work in order to make maximum use of the resources of the library. It is admitted that, in order to make an engineering library efficient along the lines indicated, the cost of upkeep will be considerable. Appropriations for the maintenance of engineering libraries are woefully inadequate and more attention should be given to securing the financial assistance necessary to place this invaluable part of the equipment of the engineering institution upon an efficient basis.

From the program of coöperation outlined, it is obvious that there are innumerable channels through which a college or university may establish relations of value with the engineering divisions of the municipality in which it exists.

THE PLACING OF ENGINEERING GRADUATES IN GOVERNMENT SERVICE DURING THE WAR.

BY WM. McCLELLAN,

Director, Intercollegiate Intelligence Bureau.

I was very much interested in a remark made by Professor Hollis in a conference at the Department of Labor on this general subject. He said he would not be very much interested in hunting jobs for college men but he would be much interested in finding men of special training at the request of the Government. This is precisely the principle upon which the Intercollegiate Intelligence Bureau, formed last February, has been working. It is in no sense an employment bureau but is an intercollegiate bureau to which Government Departments may and have resorted to a very large degree.

Everyone enters the Government service in one of two ways: either by enlistment or through Civil Service. In both cases there are Government agencies for getting men. There are recruiting stations all over the country where men may enlist. The Civil Service Commission has a very extensive organization in Washington and has agencies in many places throughout the country, through which it can personally interview men, examine them, and if necessary put them into the Government service very quickly, indeed, and with very little ceremony. For this reason any man who wants a Government job permanently or otherwise can apply to one of these two agencies, be examined, and admitted as soon as there is a place.

When the war started a number of college men thought that there ought to be an agency here at Washington to help the Government departments in getting men of specialized training that they might need in large numbers. It was clearly recognized that such an agency would have to be an emergency

one entirely, and would have to supplement the other Government departments. Therefore, the Intercollegiate Intelligence Bureau was organized and has now one hundred and seventy-five colleges, universities, and technical schools attached to it. In almost every case these institutions have sent out questionnaires to their students and alumni and have indexed their replies. At each place the work is in the hands of an adjutant and committee. The method used was somewhat new. Before that time, lists of men had been accumulated at some central place but were soon found to be useless. It was believed that if each institution was asked to keep the list of its own students and alumni, to make selections from these lists as requested by the central office and to accompany these selections with recommendations as to character and ability, the work could really be made effective. Experience has proven that it is the effective way of doing this work. The office in the Munsey Building in Washington is carried on by the director and secretary with a number of young college men, all of whom give their time gratis and pay their own expenses.

It was soon perceived that much as Government departments might need such assistance as we could render, nevertheless we had to carry our bureau to them. This is what the young men of our office did. After a time the Government departments became throughly well acquainted with the bureau and now a steady flow of calls comes to us. As soon as word comes that help is needed, the officer in charge of it is interviewed so as to get the exact specifications and then a call is sent out promptly to those adjutants who have on their lists the men needed. In almost every case we get offers of at least twice as many men as needed and the Government is in a position to make a selection.

We clearly recognized from the beginning that there would be a large amount of work done by the big institutions directly with Government offices. A head of a department in Washington needing a man of special qualifications would very likely think of his university or technical school friends in whom he had confidence through past acquaintance. There-

fore, the work of the bureau has been largely with the bulk demands for numbers of men of specialized training and not so much for the great specialist. Nevertheless, we have supplied a number of the latter.

In this form of organization we relied first, on the loyalty of our Adjutants to the United States Government and secondly on their loyalty to their college or university. A man goes into the Government service labled, and succeed or fail, he is a man of——College. Now let me call attention to three or four important particulars and then sit down.

When the bureau was started there was a large amount of easily detached, trained men in the country. First, the older undergraduates and second the younger graduates who had not been put in positions of responsibility. This conditions of affairs is fast changing and the great question in the future is going to be, where are we to get a sufficient number of trained men, not only for Government service, but indirectly for the Government through industry.

The needs of the Government for all kinds of technical services are relatively small. Labor is a certain percentage of production and you know very well that the number of plants actually owned and operated by the Government is relatively small. They will soon be filed with their full quotas of men. When this is done the calls by the Government for assistance such as we can render will be relatively small except for clerical help. True, there will always be a certain number of calls, but it is likely that the Civil Service Commission unaided, when the first rush is over, will be able to take care of the situation. It could always do it, of course, unaided, if given sufficient funds by Congress, and if it had time to extend its machinery.

The great call for help will come from industry which must come to the aid of the Government, in the manufacture of munitions and supplies. The Shipping Board, the Aircraft Production Board, the Munitions Board, the Ordnance Department, the Quartermaster General's Department—all are

placing huge contracts for material, some of it old design, much of it of new design. All of this must be designed, drawings must be made, the finished product must be inspected, sometimes before and after shipment, it must be stored and cared for, it must be distributed as needed. All of this will require an enormous amount of trained help.

Much of the trained help needed will be of simple clerical nature, but a very large part of it will be technical. We have not yet covered the technical field, and I believe that the newly formed Engineering Council will have to step in to the breach and assist. I do not believe that an intercollegiate bureau, in other words the colleges of the country, provides the most available means of supplying technical help to the Government and to industry.

We should beware of thinking that all forms of technical work can be done best by the college trained men. We had a call a day or two ago come into the bureau for a large number of inspectors and when we discussed this with the officer in charge, he very seriously opposed putting college men at the work unless it were quite impossible to get men of less ambition and less active minds. As an illustration he said, "consider a young college man, full of ambition, with an ordinary solid gauge in his hand day in and day out doing nothing but applying that gauge to shell after shell as they passed before him." It was his opinion that the college man, while perhaps better fitted than any other to superintend this kind of work where there might be some variety, would not be a very good subject to do such routine work day in and day out. This is mentioned because so many people think the college man is peculiarly fitted for anything of this sort.

What is the end of all this as we see it? I believe, personally, that it is a government board of some sort that will not only corrolate and coördinate all agencies now working to supply the Government with trained help of all kinds, but also to investigate the advance the needs of the Government and industry and to plan so that these needs will be satisfied without delaying the progress of the war. If we are sure of anything

it is that the trained men which will be needed are not now in existence. They must be trained and the great question is how is that to be done. We may not be able to answer this question off-hand, but it is the business of men like us to answer it, to get the information necessary to answer it. Perhaps we shall have to have intensive training; perhaps we shall have to arrange to borrow specialists from old plants and introduce them as the nuclei of colonies for new plants. It does not make any difference what we think of the war, I do not care whether you think it is going to end in six weeks, six months or six years, there is certainly one attitude only as a matter of preparedness we can take, that is to get ready for the biggest task which may come upon us. We must provide for a long, hard pull, which will draw on all the human resources of this country. We must put these resources so that they will be able to work efficiently, effectively, and do everything that will bring this war to the conclusion which we all long for. This is one feature which is sometimes forgotten. I have had the opportunity to talk with some of the commissioners from abroad who have been with us. Several times they have said "And that mistake may have cost 10,000 lives." This is the awful part of our responsibility in preparedness. If we do not do our part some of the fine young fellows which we are sending out may not come back—may have to lay down their lives unnecessarily.

THE CIVIL SERVICE COMMISSION.

BY MR. CHARLES M. GALLOWAY,

U. S. Civil Service Commissioner.

I have very much the feeling tonight that I am a lamb among a lot of intellectual sharks. I did not expect to come here tonight. The notice to come was very brief. I am a substitute, and therefore you will have to bear with me if I seem not to have as good a grasp of the situation as I should have.

Dr. McClellan has just mentioned the fact that graduates right out of college ought to have an opportunity to go to work for Uncle Sam, and I agree with him; and as early as March 28 the Civil Service Commission started in in that direction. We got in touch with the presidents of, I should say, about 150 colleges throughout the United States and asked them to permit their senior students who were pursuing technical and scientific courses to graduate, say, two or three months in advance of the graduation period. We have had very generous responses from the colleges; and it was with a view to making immediate use of these men who had had some training that we undertook that work.

One reason that things are not moving faster and more men are not being put to work is that Congress has not acted. Just as soon as the pending bills are enacted into law, things are going to hum. Every man who wants to work for Uncle Sam, I think, is going to have the opportunity somewhere; and I think that by that time, through Dr. McClellan's efforts and the efforts of others, we are going to have a systematic arrangement by which each man can be put into his right place.

Gentlemen, I need hardly tell you this, because all of you know it; Uncle Sam is the biggest thing in the world in the way of a business. He employs more men than any other in-

stitution on earth. His activities are as broad as human endeavor. There is not a single thing that you can think of that Uncle Sam is not engaged in. Everything that the human mind can grasp, Uncle Sam is doing; and so this is a great university you gentlemen are attending now, temporarily, anyhow.

The Civil Service Commission, in order to take care of the vast activities of Uncle Sam, holds more than four hundred different kinds of examinations every year, and I think now, beginning with this year, the number will reach probably six hundred or seven hundred.

Of course you gentlemen are interested in engineering largely. I may tell you that the Civil Service Commission secured for the Interstate Commerce Commission, for the valuation of common carriers, practically its entire force of engineers—in fact, the kind of a force that is needed and required to build a railroad from beginning to end, to value the common carriers throughout the United States. With a few exceptions, perhaps six or eight, every engineer of every kind that went to work for the Interstate Commerce Commission in the valuation work was secured through the Civil Service Commission; and the Interstate Commerce Commission in its report for 1913 was good enough to say of the Civil Service Commission that it could not in any other way have obtained such valuable men as it did obtain through the Civil Service Commission. Well, we felt a little set up over that. That was a pretty good bouquet.

Now, to get back to the proposition of offering services: I need hardly tell you that everybody in the government service appreciates the patriotic spirit exhibited by you men who are training young men for their life's work; and the only reason that you can not go to work today and do something is because we are not ready, but soon we will be ready, I believe. It is difficult for me to say how many appointments have been made through the Civil Service Commission in the last sixty days. It runs away up into the thousands, and we hear reports from the departments, estimates of something like five thousand

here and seven thousand there, two thousand here, and so on. We cannot tell, ourselves, what the needs of the service are going to be; but we do know, at least we feel, I feel personally, that every man who wants to do something is going to have the opportunity at a very early time.

I may say that the Civil Service Commission first started the work of examining civil engineers as early as 1896. Its first efforts were directed solely toward securing civil engineers. The needs increased with the growth of the service, and the growth has been constant and great, until now we are examining engineers of all classes for a great many services in the government service. If you gentlemen are not familiar with it, I will say to you, probably some of you have already served for us at the meagre sum of $10 a day in the preparation of questions and examining the answers. We have a small fund of $2,000 a year for the employment of expert services. Sometimes we are able to get patriots, men whose services are worth a hundred dollars a day, for as little as five.

I wish I had gotten here a little earlier, so as to have heard what Dr. McClellan has had to say. I know he has talked interestingly, as he has talked every time I have heard him.

I wish to say again that the Civil Service Commission certainly, and I am sure all other departments of the government, appreciate the tender of services, and hope to be able to use a good many of you before very long.

I thank you.

Discussion.

I. W. Litchfield: I never led a discussion before and I do not know exactly what it is like. When I read, however, the fact that I was to lead this discussion and saw the able coterie of discussers that were to bolster me up afterward, I felt better about it. I was reminded of a very pleasant remark that Dr. Tyler made one morning after we had a class dinner in New York, a somewhat convivial one, when he said that he saw a very dear classmate of mine leading two porters to the train. I had three coming in.

I think that an engineer's idea of preparation for a war like this would be a general conservation of all the resources of the country, made as quickly and as accurately as possible, with the idea of bolstering up those industries that were most needed for purposes of producing material for the war, and also of making a survey of the personnel principally of the engineering resources of the country at such a time as this. Now, I do not think many of you can quite understand the situation here in Washington as it was three months ago. I do not believe that if we had simply brought our goods here, our engineering graduates, with their records, and had said to the Government "We have these men: they are crackerjacks; they can help you; they are just the men you want," and sat down and waited for them to call on us, we would have had many calls for some time. As a matter of fact, the army particularly, is spread very thin. You know that. You know they need all the men, all the regular army men they have, largely to train troops. In the ordnance and engineering divisions they have pulled in the lieutenants from the arsenals. Students who three months ago were working on machines in some of the arsenals I recognize here in Washington today. In some of the buildings here, large dwelling houses, of which there are ten or fifteen perhaps, devoted to ordnance alone, you will find a colonel, possibly a major, two or three captains and two or three lieutenants, and there may be twenty-five or thirty reserve officers under them. In one building, on one floor where there are perhaps twenty-five officers, there is one man who was a lieutenant a few days ago, but who is now a captain.

If you could have gone into some of these offices and talked with some of the young lieutenants who have just come from the arsenals about their work, you would have discovered at once that they needed advice, that they needed help. It is all very well in theory to say that the Government should come to us and ask us for help. Now, the Government is a very complex institution. People come on here to talk with the Government and they see folks just like you are and they see

hundreds of them; they see thousands of them and they all have their individual problems and they did not know, as many of you do, most of you do, the elements of stock-keeping, of perpetual inventories, of how to place orders, of how to keep track of them, of follow-up systems and all those things. They had had, probably, some lectures on them, but never any practical experience; at least, a great many of them did not. So it became almost necessary to go to them and say: "You need such and such help"; and it became just as necessary to find the particular best man for that job because that particular best man is the man who is going to be hiring other men, and each of those men will be a focus of activity.

I do not know what the expansion of the army has been; but I talked with several officers within the last week or two, and the guess is, between two and three thousand officers, and that it may increase two or three times that before the war is over. Now, where does that leave the regular officers and how many reserve officers are there going to be? I am speaking now of the engineering side of the Government, particularly, here in Washington and at the arsenals and not at all of the committees of the Advisory Commission of the Council of National Defense, the various committees that they have. It means that the engineering officers who have graduates at West Point will be perhaps one in fifty, and they certainly need the best talent we can bring to bear. Now, there is a question—and I want to say that this discussion is on the placing of men. I do not agree with Dr. McClellan that it is our simple duty to secure the men, to find out where they are and offer them. I think we ought to take them to the departments, if we know, if we are satisfied, if we are absolutely sure, that those are the men they want, and give them to them; and we want to take the very best men we can get. Gentlemen, this is war; and I wish you knew—and you do, many of you, but some of you do not—how intensely this Government needs the very best brains it has to prepare for what is coming. We are going to learn about it pretty soon.

There is another matter, and that is the question of organizing industry. The number of men that we are going to need for such principal places as have been and are now open is not tremendously large. The number of men that we would take for that purpose is not going to disorganize any industry. It might if we took them from any one large industry; but coming to us as they do from all over the country, I have felt and our committees felt and those that I have talked with felt that we ought to find out where the best men were to fill particular positions of importance and offer their names to the Government and let them make their own arrangements with the men. There is a great patriotic offering of service now. I have gotten men who perhaps were receiving forty or fifty thousand dollars a year to come to Washington and take a major's position, and sometimes a captain's position. I have not many of the forty or fifty thousand dollar men, of course, but many getting large salaries have come here on captain's commissions and even lieutenants commissions because they want to serve their country. There is this great outburst of patriotic devotion; and when we have written to the men who have offered service, men whom we want, men whom we know will be useful, we have found, almost in every case where it was possible for a man to leave his businesss, to leave his family, to leave his home, that he was willing to come and serve his country.

There is another thing: If we are going to have goods to sell, we have got to know what the goods are. We have got to know the character of the men and their experience before we can say to the Government department: "These are the men, this is the man that you want." So it would have been a very great thing if early in the game we had been able to "dope out" a standard question sheet that could be used by all engineering societies, or at least with variations. Now, that did happen, and you have been called on to make out a number of sheets, and there is a criticism of overlapping and all that sort of thing. Gentlemen, I do not think it is much to ask you to make out one every day when our boys in this war are

offering their lives at the front. In order to get what we are going to have there has got to be waste. There are all kinds of waste going on. It cannot be helped. There are duplications of orders; there are materials that are misplaced; there is waste. It is not like a factory that you own or run or are interested in, where everything is in apple-pie order, and everything runs smoothly, and you know where every dollar's work is at any time, and everything is correlated and assembled as it properly should be. It can not be, and so we have got to have overlapping in question sheets and questionnaires; and for Heaven's sake do not kick if some society comes around and asks you to sign another sheet. It may be very necessary and it may not be; but at least show that much devotion to your country.

There is a phase of this condition in Washington that is very satisfying, and that is the opportunity of the engineer to take his place in the Government service generally. I do not know how many engineers have been placed in Washington and in the engineering features of the Government service, but certainly several hundred, perhaps two thousand, perhaps more; perhaps three thousand. I have not any idea. I know that we have probably placed somewhere between four and five hundred from the Institute of Technology, and these men are finding out a whole lot about the Government. They are finding out some bad things and some good things, some that are going to help the Government. The good things are knocking out the false notions that may have obtained, old-fashioned ideas of how the Government was run, and so on. It is true that there is lots of red-tape here, but I think you will find that every young officer certainly, and practically all the officers, are very anxious to do away with it; and I am sure that these Reserve Officers that are coming in are clipping it and cutting it so scandalously that it is a wonder some of them are not put against a wall and shot to death. There are so many of them that they get by with it, and I think it is going to mean a good deal of change, certainly in the army system of doing business.

On the other hand, the army officers and the navy officers

have welcomed this influx of engineering talent with open arms. Without you men they could not have done anything. They would have been absolutely helpless. When they have to build a large number of aircraft they can do the preliminary engineering, they can decide on what they want, the number they want, the various types of machines and engines, but when it comes to production they simply hold up their hands, and it was necessary for the engineers, and especially the automobile engineering talent of this country to come to their assistance and to build those aircraft. I believe that now is the opportunity for the engineer to take his place in this country as he should, and I think that the one trouble with the engineers is that they do not push themselves forward enough. They do not realize, as some of the societies do not realize, that if we are to be useful to the Government with our men, our graduates of engineering institutions, we have got to do more than say; "We have them." We have got to actually place them, or at least we have to offer our goods in such a way that we can make a sale when we know that the customer needs those goods.

So I believe that the engineers of this country ought to push themselves forward more, because the country needs them. It needs them generally, not only in Washington but in municipal affairs. I see before me a number of engineers who have recognized this and who have taken high places in municipal and state affairs and the affairs of the country. I hope that that will become a habit of engineers; and in that way the profession will be dignified, and the country will realize what the engineering schools mean to it.

W. M. Thornton: I have listened with great interest to the speakers who preceeded me, as we all have. They represented a side of this interesting question with which we college men are not especially familiar. They have been active in picking out college men for the jobs that the Government wants done. Our business has been all along to train college men so that they would be ready for almost any sort of a job; and we have thought not so much of placing our graduates in the public

service as of turning out well-trained engineers who could adapt themselves to public service or private service, to industrial life, or to any position in which a well-trained engineer ought to be able to make himself useful.

For my own part, I am persuaded that that is the true function of the college. The Chief of Engineers of the Army told us this afternoon that there was not much military engineering except being able to get things done, even if the conditions were unfavorable. It is like the famous old story of Jackson's bridge-builder. Jackson had to cross a river down there in Virginia during the Civil War, and he called his chief engineer and told him he wanted a bridge built. The chief engineer went and drew the plans and brought them to the general, and the general called his head carpenter and handed him the plans and told him to build the bridge. "All right, General," he said, "the pictures look fine, but the bridge is ready; you can march over it." The carpenter had built the bridge while the engineer was drawing the plans. I suppose a good deal of military engineering is always going to be like that. Still, there are some bridges that the chief carpenter will not be able to build. There are some engineering tasks that the mere practical men will not be able to handle; and it is that sort of thing that our graduates have to be called in for, in the long run. They have to be called in for work where trained intelligence is needed, where they cannot get along without it.

I hoped to hear, in the discussions that went on at this meeting some further details of what the colleges can do to fit their courses to meet the present emergency. So far, I have heard very little. I hope that something will be said that will throw some light on that before we get away; but if we are to do much in the way of fitting our men specifically for the public service, it must be done in the direction of so adjusting our own courses of instruction that they will fit the immediate and present needs of the Government; and if we could learn in any way what is lacking, if there be anything lacking, in the training of college students, students of engineering colleges,

where they need reinforcing, I think our professors would be very ready to meet the issue and to train the men.

My own experience has not been that much was necessary of that sort. We have had draftsmen from our School go right into the Newport News Shipbuilding Company and do good work for them without any very special training. Of course, they had to begin down in the drafting room, but in a few weeks they were up doing important work. We have had men in the same way go into the Norfolk Navy Yard, and just in the same way they have gone into the munition works. Well-trained graduates have shown themselves capable of filling those positions, meeting the obligations that were put upon them, and meeting them promptly and meeting them well. It is the general intelligence of the young engineer that comes into play, his general training and adaptability to meet any problem that may be brought to him, that I conceive as the most important thing, and that is the thing that the colleges must maintain at all costs.

I am quite willing to see a good deal of comparatively useless material cut out of the college curriculum, if it be necessary; but the things that develop intelligence, develop adaptability, develop the mentality of the student, are the things that we must insist upon and that we must urge upon our own men.

As far as getting information for the Government is concerned, I suppose all schools have done pretty much the same thing. We have made a census of our alumni. We know where they are. We know, in each case of a man of scientific training, what he can do, what he is doing. We have that information ready for use by the Government whenever they may want it. They have been card-catalogued, and we can lay our hands on them. We have been doing the same thing with our recent graduates; that is, we are keeping up with them. Not many of them have gone into public service. Most of them have gone into industrial work; but we know where they are, and we know what they can do. I do not know that college men can do anything better for the Government than to go on with their teaching, and at the same time keep an ac-

curate census of the positions and capabilities of their graduates, know where they are, know what they can do, know what they could offer to the Government in case their services were wanted.

Maurice R. Scharff: My experience in Washington in connection with the placing of engineering graduates in the government service has been along such exactly similar lines as that of Dean McClellan and Mr. Litchfield, that it could hardly be expected that I could add anything very different to the discussion from that which they have said; and so I am not going to attempt to do so. I am only going to say over again, perhaps in somewhat different words, two or there things that occurred to me as worthy of some further emphasis.

First, I want to second very heartily the hope expressed by Dr. McClellan that there may soon be established some effective central agency for coördinating the work of the various organizations that are now working independently along this line of placing technical men in the government service. We of the Massachusetts Institute of Technology have been criticized by some because we have acted independently, because we have established a Washington headquarters for a single institution. I would like to say that the only reason we have acted independently has been because we have been unable to find any central coöperative agency with which we could merge our activities and secure as effective results as we feel we have been securing.

I would like to go further and say that the moment such an effective central agency is established, we will be only too glad to immediately merge our activities along these lines with those of such an agency.

The great national engineering societies, the technical colleges which you represent, present themselves naturally as the bodies out of which such a central agency may well develop, and I want to sincerely second the hope that out of these organizations there may, before long, grow some such coördinating coöperative agency. The second thing I want to repeat is something to which Mr. Litchfield referred, and that

is regarding the necessity of "selling service" to the government. I do not mean by that going around and attempting to find places for our graduates or for anybody.

I believe, as Dr. McClellan said, that we are not interested so much in placing technical graduates in the government service as we are in placing at the disposal of the government, on demand, the resources of the colleges. Anybody who thinks that he can come down here to Washington and open an office and sit in it, and wait for the War Department and the Navy Department and the various other technical services of the government to come around and take advantage of the facilities which he knows he has to offer, is going to be very sadly disappointed. Even if we get an agency here in Washington representing all of the national engineering societies, all of the technical colleges; even though it represent one hundred or one hundred and fifty thousand engineers and technically trained men, it will still be necessary for the representatives of such an agency to keep in constant personal touch with the departments; to keep themselves informed of their needs by actual visits; to discuss with chiefs of bureaus their present and prospective needs; to help develop by such discussion the character of such needs; and to stimulate at all times the interest on the part of the departments in the facilities which they have to offer.

The third thing I want to speak of is an additional reason, in addition to the advantage of coöperation, for the organization of some kind of a central coöperative engineering agency here in Washington. It seems to me that if such an agency is established, and if, as is probable, it has occasion, in connection with the placing of technical men, to circulate information at intervals among the members of the associated societies and colleges that support it, there may very well grow out of any such activities some sort of bulletin service or news service to technical men, which may well tend to stimulate the formation of public opinion among our technical citizens on problems of public policy of an engineering character. Many of the public problems that we have had to face since the beginning

of the war have been of this character. Such problems as the effect of volunteer enlistment on industrial organizations, the composition of exemption boards for administering the conscription act, the establishment of criteria which shall serve as the basis for exemption, and so on, are in a considerable sense engineering problems, and the opinion of our technical citizens ought to have as much influence in determining those problems as the opinion of any other part of our citizenship.

One of the great opportunities for any such central engineering agency as has been suggested, if established here, would, it seems to me, be to encourage the formation and expression by the technical men of the country of public opinion on public questions of an engineering character; and if such a thing could be brought about, it would, I believe, go far to give the engineer, as a trained citizen, the place which he should have in the civic life of the community.

F. P. McKibben: The topic for discussion is the placing of engineering graduates in government service during the war. I suppose you have all had the same difficulty that we at Lehigh have had in knowing just what "government service" and "industrial service" mean, and where we should desist sending men into industrial service and divert them into government service. Frankly, we have not had very many applications at Bethlehem for men for government service other than those sent through the United States Civil Service Commission. When the United States Civil Service Commission sends an application to Lehigh University for a man, the application does not stay around very long before it is sent on through the mail. The civil engineering department immediately sends out a bulletin to every civil engineer graduate that is thought to be fit for that work. In the same way, if the Collegiate Intelligence Bureau sends out a request for men, as it has recently, we pick out from our card catalogue the men whom we think are suitable for the position and send everyone of those men a notice that we have informed the Collegiate Bureau and have recommended the men in question.

What is "government service"? You must have all had

to solve that recently when the question came up for early graduation. Shall we graduate early those men who enter the United States army only, or the navy only? Is the building of a battleship or a torpedo-boat or a sixteen-inch gun by a corporation a government service? It clearly is not, but it is just as important, and we of Bethlehem feel that it is wrong to divert our men from the engineering courses of Lehigh University into work for which they are not trained, when corporations working on government contracts are clamoring for men. Therefore, we are doing our best to hold our students until they have a reasonable amount of training, and we are doing our best to find the proper place for each man. There are some of us who have been giving practically all our time to that work.

Shipbuilders are asking for men daily. One manager says he will take every man that we recommend. I suppose there is a limit, but he has not stated the limit. The civil engineering department at Lehigh University has had seven hundred and ninety applications for men in the last twenty-three months. These men are wanted mostly in industrial works. Comparatively few are wanted by the United States Government, either as engineers or in allied work.

The Civil Service Commission, it seems to me, is serving the government in an excellent way in getting men. I have seen something of the working of the commission in connection with the selection of men for the valuation of our railroads. In connection with the three thousand papers which I saw, but only a few of which I examined, I was impressed with the thoroughness with which the Civil Service Commission did its work. I was impressed also with the many lax letters of recommendation from college authorities regarding its college graduates. I took a solemn vow unto myself at that time that hereafter, when the United States Civil Service Commission or anybody else, in fact, asks for a letter of recommendation on a graduate of the civil engineering department of Lehigh University, that they, either the United States Civil

Service Commission or anybody else, will get the whole truth and nothing but the truth. If I can not recommend a man, I will plainly say so. I saw many letters of recommendation for men in connection with the applications for positions in the valuation service, filed with the United States Civil Service Commission, which bore every earmark of being simply a complimentary letter, when compliments were not called for. Thoroughness in selecting men for the United States Government was important then. Thoroughness in selecting men for the United States Government is even more so today.

I presume the fact is that in our town of Bethlehem, where the steel works before the war employed seven thousand men and are now in the same works employing thirty thousand men, we have somewhat distorted views about the requirements for government service. We think government service includes building guns and building new shops in which to make those guns. So it is difficult to say, then, where government service stops and industrial service begins.

I believe you are all interested in securing the best men for the various departments in Washington, and when those departments ask us for men, if they will be as specific as possible in giving us information about the age and qualifications of the men they want, I am sure we can give them the men if we do have to steal them from someone else.

F. H. Newell: It had already been shown that the demands for men needed for immediate service have been met in large part, also that we have practically exhausted the easily available stock of scientifically trained men. The time is rapidly approaching when it will be more and more difficult to get the right kind of man, because the kind of man that we wish to recommend is the man who is already engaged in work of importance and who should not be disturbed.

The point has already been made that while the government service requirement for engineers is relatively limited, the industrial requirements are rapidly growing greater. If, to fill a particular need, we attempt to get the best men we know, and take them from one place to fill another, we may be doing

more mischief in taking them out of the old places than we are doing good in locating them in the new positions. We must look at this question from many sides—that of merely finding a place for a competent man being the simplest and easiest of all—we must ascertain with great care, what is really needed and whether in attempting to fill that need, we are not doing someone a great injury. Judgment based on long experience must be exercised and what is equivalent to a priority board or committee established.

As engineers we should try in every proper way to get engineers into the government service, both federal, state and city, because we know that the engineer, "the man of ingenuity" has the ability to fill many of these places better, for example, than the lawyer, who has been and is considered to be the typical leader in all governmental affairs. As you are probably aware, there are in the legislative branch of the government less than one half of one per cent. of engineers. The great body of legislative talent in the country, the lawmakers, are the lawyers. Over seventy per cent. are professional lawyers, and many more have been educated as lawyers. The feeling has developed that if you want a man of initiative, a man to do things, a man to place at the head of a bureau, or department, or other branch of the government, you must get a lawyer; then the lawyer can hire an engineer! That is one of the popular concepts which we, as educators, and as engineers, must combat if we are to aid in putting into the leading positions the men whom we believe are best qualified to fill those positions.

Every man that has gotten properly into the place where he is most needed in government service, every engineer in responsible charge as the head of a bureau, commission or board, immediately demands that his assistants shall be not merely young men of energy but more than this, men who have been trained as engineers. Thus each place properly filled with engineers, where engineers are needed, means that added opportunities are provided for other young men to enter as subordinates.

We have a double duty, first, that of ascertaining where men are needed and second, that of supplying the need with engineers. It has been shown that we can not sit down and wait for the government officials to come to us. I have heard the expression used at a meeting of engineers representative of the four national societies, that we have done enough when we have presented to the President of the United States the fact that the engineering societies can and will do anything that is required of us, also that we should take a dignified position and abstain from further activity until we are called upon by the President or by the members of his cabinet to lend our aid in the present emergency. If we do wait, it will be many months before they call upon us. The letters that we have sent as individuals, as members of societies, are here in Washington, it is true, but where are they? Probably scattered through scores of files in various rooms of the Navy, State, and War Departments, in the Civil Service Commission, at the Treasury Building, and in the various other departments in different parts of this City; or sent to the State Council of Defense. There are literally thousands of those letters offering services, so many that many of them may never have been read except possibly by the stenographer who prepared the reply for the signature of the head of the office.

When the man who wants an engineer, who needs an assistant, appreciates that want, he can not hunt up those letters, it would require days, even if he had the time. They can not be quickly found; they are filed away in boxes and in transfer cases in rented buildings, scattered here and there throughout this city. It is easier to write, calling again for aid than it is to hunt up letters now on file offering services.

The point to be made is that this work of aiding the Government and its agencies to win the war, by getting the needed men must be so planned that we first find and clearly describe the need. We must tactfully hunt out the official who has the need, and often does not appreciate that he has this need; then explain it to him how he can be aided, and that there already exist certain channels for getting hold of the right kind of

assistants. We must be ready to supply those men to him, and thus earn his everlasting gratitude as well as perform the highest function that we can perform for the nation's need!

Dr. McClellan: One question brings up a very interesting point which will take a moment's time to answer. You cannot sit back and expect the Government to make use of your resources because you have them. You are in the position of the salesman who goes out to make a sale—you know you have something of great value, but you have to sell it. For that reason our Bureau has gathered about eight men who are continually going back and forth in the Departments of the Government trying to be of service.

The dean of the University of Virginia brought out another important point. It is difficult to get the average Government officer to understand the value of disciplined, trained mind, even though it has not had the narrow, specialized training that he needs at the time. They are beginning to know, however, that a well-trained engineer can quickly be adapted to a great variety of services. It is mainly for this reason that I strongly recommend as a result of my experience here in Washington that there has been no change in the courses given by the schools of this country for the needs of the war. Let us give our men broad, fundamental, technical training, and trust to their mother wit and to their American adaptiveness to fill special needs. Moreover, we must look to what will be upon us at the close of the war. At that time many of these special needs will disappear suddenly and we shall need above everything else men whose training has been broad and deep and general strong. Therefore, whatever we do, let us not cut off the supply of such trained men.

F. H. Gilbreth: I think perhaps I can be of little help to you in this problem of getting the men for the job and finding the job for the men. That has been right along my line of work, long before this work came on and since, and I want to call your attention to this method of doing it.

There are on the markets at the present time three devices. I might say I am not financially interested in any of those

devices. Those devices will permit of the easy classification of over a million different kinds of experienced men and over a million different kinds of jobs. They can be operated electrically, or in what you would call the card file box. One of the most important things that we need, of course, first of all, is to get the man in the right job, and the reverse getting the right job for the man. Oftentimes, we steal our competitor's man in business because he has a little special knowledge that we want. This is the era of the engineer. If we engineers can not handle this thing properly, we are to be pitied, and we have no right to say that engineers should take the place of the lawyers. As a matter of fact, we can very easily handle this thing. Let us see how we will do it.

A very fine step in the right direction has been made by Mr. French and Mr. Bullock of the American Society of Mechanical Engineers in the way of getting the experiences of the various members of that Society. They have gathered all this data on a specially prepared blank form which I have seen, and of which I make just this criticism, that they have not gone far enough. If we will send out and get their experiences from all the engineers in this country and will classify them, we will then have that data readily available. It is a big job to bring about this classification, this being a job of classification, and not the job of an engineer, not the job of a higher mechanical training, but it is a job in the science of classification which, I am sorry to say, is not taught in any school at thepresent time. If we will send out and have them fill up a blank, giving their experience from the time they first went to school, right straight through, what they worked at during the summer vacations, what their hobbies are, what their specialities are, and everything of that sort, we will then have the original data right. With the original data it is wholly a matter for the statistician and it becomes a very simple matter for a man, with any one of these devices, to answer any question readily, instead of having the terrible trouble of looking through a card file, as one of the speakers said, or as another one said the trouble of writing out anew each time an inquiry comes in.

We will then be in a position whereby we can have that information at our finger ends from any one of these three systems, and simplify this matter very greatly. I do not want to take up the time of the meeting to describe these devices, because I could not do it in a brief time, but I will say to those of you who may be interested in it that I shall be very glad to talk to you about them if you care to hear about them.

The possible jobs can be listed in the same way, and consequently this central bureau, which one of the speakers is offering to co-operate with, could thus be aided in a material way. We should also have all the engineers of the country and all the possible jobs in the country listed, classified on a scientific basis, and so arranged that if an engineer exists who does not want a new job, but wants special information on a certain point, he can send to this central bureau and can have the name and address of every man who has specialized in that particular thing, and we will then have what they have in Germany to a very much greater extent, and that is that any man working on any particular thing has the name and address of every other man that has had a highly specialized experience along that line.

I think you will all admit that we need very much in the engineering profession a central clearing house, and that is the basis for it. It is the simplest thing in the world. I have done it and there is not a problem about it. It is merely a question of classification, and if there is anyone interested in it I shall be glad to take it up with them in detail at any time.

H. Wade Hibbard: I want to heartily approve of what somebody has said here tonight, that this is no six weeks' war or six months' war. I believe we ought to prepare for a ten years' war. Perhaps we will win before ten years, but we have got one big job for this country. There is only one job for this country to do. We have only one job. I have been serving the government in Washington longer than most of you have, and I have come to realize that this country has one job and one job only before it, and every man, woman and child in this country ought to be engaged in doing those things

that lend themselves to this one job—and that one job is to smash Germany!

W. F. Durand: I did not know until about five minutes ago that I was going to have the privilege of talking to you this afternoon. I see so many old friends and acquaintances in the audience that I feel quite at home, however, but I must warn you that I have nothing prepared. I came without notes and without any preparation whatever, and therefore I can only attempt to speak to you for a few minutes in quite a discursive manner with regard to the activities of the National Research Council.

How closely those activities may lie to the subject which has been announced by the President, I am not able to say, but in any event I shall hope to tell you something of the work which the National Research Council, and especially the Committee on Engineering, has been doing during the past few months.

As most of you undoubtedly know, something more than a year ago the President asked the National Academy of Sciences to organize a National Research Council, with special reference to the investigation and study of the scientific problems which might arise, but at that time, of course, without specific relation to the present war conditions.

The work during the first few months was largely preliminary in character; but with the approach of clouds indicating a probability of hostilities, in the early spring, active organization became the order of the day, and the Council was organized under a variety of committees and subcommittees intended to deal effectively with such problems as might be expected to come before it.

The theory which at that time was developed by the organizers of the Council and which has prevailed since that time has been an organization twofold in character, an organization according to function, and an organization according to topic. These of course are quite obvious methods of organization. It is perfectly clear that there should be one particular body so organized that it will naturally take care effectively of the problems which may arise in

any one clearly specified field of scientific work; and according to this idea there have been organized a very considerable number of standing committees; thus, a standing Committee on Physics, on Chemistry, on Agriculture, on Engineering, on Medicine and Hygiene, on Botany, and on a variety of other topics which I need not take time to name.

Again, it will be clear that there will be certain specific problems which will arise, definite in character but perhaps involving a variety of types of scientific work; specific problems which could not so well be assigned to the work of a single committee such as those which I have just mentioned. In order to properly care for problems of this character, a mode of organization on the basis of function or problem has also been developed, and so we have had a considerable number of special committees dealing with particular problems: thus, a committee on the nitrate problem or the so-called Nitrate Committee, dealing with that most important question relating to the development and conservation of our national resources.

Again, a committee on the problem of optical glass. We have, as you know, been accustomed to bring our optical glass mostly from across the water, and under present conditions we are not getting it from abroad, in any event in quantities in any way adequate for the requirements. So it became absolutely essential that the country should mobilize its forces in one way or another with reference to the development of the possibilities and production of optical glass. This obviously requires the coördination of a number of different agencies; physicists, chemists, engineers, metallurgists, etc., and so a special committee representing these various factors which enter into the production of optical glass was organized and has been doing most excellent work. If you are not already informed, it will perhaps interest you to know that we are now very nearly, if not altogether, in the way of producing a good supply of optical glass, reasonably adequate for the requirements even under war conditions, and of very good quality. This has been largely due to the work of this committee co-

operating with a number of previously existing agencies, in particular the National Bureau of Standards and the Geophysical Laboratory under the Carnegie Institution. At the present time there is a certain amount of optical glass being produced at the Bureau of Standards, an amount which is by no means inconsiderable. At Pittsburgh also measures are now in the way of being developed which will serve to supply this glass in very considerable quantities.

Again, there is the all-important, the overshadowing problem of the submarine, which again calls for the coöperation of many different sorts of people, and so a special submarine committee has been appointed to coöperate with the various other agencies of the government having relation to this particular problem, such as the Naval Consulting Board, the Navy Department directly, its various bureaus, and at least two specific committees organized under the Navy Department and dealing with the various phases of the submarine problem. I wish I had the time to tell you more in detail regarding the work of this committee. It is perhaps the most important single committee which has been organized under the auspices of the National Research Council, and its work has been certainly very interesting, even if the results thus far have not run as far as we had hoped they might.

A number of other special committees might be mentioned. I may mention only one—the Committee on Gas Warfare. As little as we may fancy the notion of gas warfare, the United States must be able to repel gas attacks, to say nothing of going any further. I may say furthermore that the National Research Council, representing the scientists of the country, does not consider that its primary function is to determine the policy of the government. If a problem is placed before it, it conceives that it is its duty to develop the scientific factors which enter into the development of such a problem, and it leaves to what we may properly call the "higher authority" to determine the extent to which these scientific factors shall be embodied and employed.

Omitting further reference to a variety of other special com-

mittees. I am going now to take a few moments to tell you a little more in detail with regard to some of the activities of the engineering committee, in which perhaps you will be more especially interested.

The Engineering Committee, as such, was organized a little later than some of the other subcommittees, this for one reason or another which it is unnecessary to speak of here; but this particular committee was not organized until about two months ago. At that time the four major engineering societies appointed a certain number of representatives, which representatives, together with a certain number of other engineers likewise representing these various societies and who had been previously appointed on the Research Council, are understood to constitute and form an engineering committee of the National Research Council. That committee organized with Mr. Gano Dunn as chairman of the committee, and I have the honor to serve as vice-chairman in immediate charge of the activities of the committee in Washington. The primary question which naturally arises in connection with the formation of any committee is this: "What is it good for? What is it going to do? Why add one more to the number of committees which already exist in such great multiplicity?"

And here I may say that, coming to Washington about three months ago, that general query was one of the first things which impressed me very forcibly. On the road from disorganization or lack of organization toward an ideal state of efficient organization, we were passing through a phase of what seemed to be a very great *over*-organization, and so we found a great variety of boards and bodies and councils and committees and advisory bodies of one sort or another, not always with the line of demarkation clearly drawn between the functions and the operations of one board and another, and very likely with certain areas of activity left out entirely. As time goes on, we see continuously an improvement. We see that unnecessary and ineffective elements are dropping out of operative life, and those elements which remain effective and operative naturally will continue; and I suppose that there is

perhaps no better way than to possibly over-organize at the beginning and attempt in this way to eliminate the unnecessary, and to finally arrive at a condition where our organization will be adequate and without redundant elements.

In any event, that is the question which naturally arises in connection with the organization of any committee: "What are you going to do which is not being done already, or are you going to do something better than some other organization which is already having cognizance of such field of human activity?"

Hence the fundamental question which came before the engineering committe, was. "What are you going to do?" From the standpoint of the engineers of the United States the committee felt that it was going to represent thirty or forty thousand professional engineers as best it might with reference to the mobilization of their services for research intended to serve the immediate needs of the government, in so far as such needs could be made clear and transmitted to us for transmission to you and to other engineers all over the country.

It is one thing for an engineer or for a body of engineers to say "We want to serve the country," or "We want to serve the government," and to offer services to this or that branch of governmental organization. It is a very different thing to receive from such a branch of governmental organization a series of clean cut, specific problems, definitely organized and stated, so that they may be immediately parcelled out to those particular individuals who will be best suited to deal with the investigation of such problem.

The ideal condition would be of course to imagine that the governmental bureaus would have in their pigeonholes several hundred or several thousand problems, for due attention to which they were waiting on engineers. They would have them each labelled and organized as to characteristics and the kind of men who would be required for the study of such problem. and as soon as we could indicate our readiness to serve the country they would immediately reach to the pigeonhole and hand out the problem. That is a beautiful ideal, but as you

know it does not work that way at all. We must come by our problems in a very different kind of way, oftentimes in quite indirect or measurably accidental ways.

Fundamentally, we start with the assumption that it is the function of a governmental body, the Army or the Navy as the case may be—and of course our present activities are related to problems coming before the Army or the Navy—to first state the problem; to state the end which is desired and the controlling conditions and limitations. In such cases where a specific formulation can be obtained, we may then hope to approach with some probability of success the matter of placing such problem with those engineers who will be best qualified to cope with it. But that is just where the difficulty arises. We do find—and it is to be expected—difficulty in receiving such clean cut, direct, full specifications regarding the problem as will best enable us to place them where they will best be taken care of. One of the problems which comes before us in the broadest possible way was the one which I spoke of a few moments ago, the problem of the submarine. Even with regard to that problem it is none too easy to develop the kind of specifications desired. We all know that we want to find an answer to the submarine; but what elements constitute an answer to the submarine? Is there one answer, or are there hundreds of answers? What factors enter into an adequate and sufficient answer to the submarine problem? In order to realize definite answers to these necessary preliminary questions, we of course, have had to go to the Navy Department and I desire to assure you that the Navy Department has received us with the utmost cordiality and has given us every possible aid in arriving at a full understanding of the broad conditions to be met in coping with this problem. But there the problem subdivides and the ways are long and devious and the end is not yet.

With regard to many other problems, the contact between the Research Council and the problem itself often arises possibility with an element of hazard. I can best illustrate by one or two examples. It so happened that a member of our engi-

neering committee who has lunching with one of the officers of the ordnance bureau of the Army, was discussing the general situation and the question arose rather accidently, regarding the influence of copper on iron which is intended for producing projective steel. An old specification called for iron free from copper, and the government has been paying an excess price for such iron. The question immediately arose, is that necessary, or is it handed down in some traditional and historical way? What are the facts regarding the the influence of copper on iron intended to be used for projective steel? There was no apparent answer offhand, and the question came up, can the Research Council or its Engineering Committee undertake to develop any information on that subject? Obviously, it was a problem exactly in our line. If we are good for anything at all, we should naturally be able to develop at least the existing state of information regarding this particular problem. So it came before the committee, and we proceeded to get into telegraphic communication immediately with the leading metallurgists of this country and to ask their opinion regarding the matter, and asked furthermore for the names of men who would be qualified to undertake an experimental investigation regarding this problem. Furthermore, we cabled to England to develop there the opinion of the leading ordnance manufacturers with regard to this particular question. All these were matters entirely routine, and such as would naturally be suggested. They resulted, however, in the development of a very considerable amount of information, information at first hand as well as information developed from literature on the subject. Among other matters developed was a very considerable bibliography, covering fifty pages of typewritten matter and giving the titles of articles in recent years relating to the influence of copper on iron. All this information was furnished to the Watertown Arsenal and I believe has been of material aid in reaching a conclusion as to the importance of this old feature of ordnance specifications. But the first contact with the problem developed really by chance. If the member of the

committee and the ordnance officer had not chanced to lunch together, the problem might not have been presented.

One more illustration of the same sort of thing: I happened myself to be riding home after office hours one evening on the street car with a friend who was a Naval Constructor. He mentioned some difficulties which had been encountered in connection with the standardization of battle-grey paint, and wondered whether there was any way of getting at the problem in a scientific manner; getting at what enters into the standardization of paint, especially those pigments and colors which enter into the so-called battle grey. Immediately the telegraph was started and the best paint experts within one hundred miles of New York City were developed and brought to Washington for conference and contact with the problem, and it resulted in the giving of a number of very useful, pertinent suggestions to the government with regard to specifications and with regard to its method of preparing the paint and which, it may be hoped, will go far toward removing the difficulties which were to be met with.

I must now go on to say a few words with regard to the services and the activities of the committee with reference to aëronautic work. That, as you all know, is at the present time very much to the front. A program is at present outlined and under consideration by Congress which looks, as you know, to a tremendous development, entirely out of class with anything which we have ever known or ever dreamed of before. In order to deal with this particular phase of governmental requirement, the National Research Council at an early date appointed as its aëronautic committee a previously existing body. Some two or three years ago, in the years of the first Wilson administration, under act of Congress, there was appointed a national advisory committee for aëronautics, and that body has been in continuous existence and operation since that time. It has a definite status by virtue of Congressional law, an appropriation of its own, a very considerable organization, and has been in active existence since that time. It was obviously unnecessary and it would have been ob-

viously doubling up on committee work for the Research Council to appoint a separate committee with cognizance over the subject of aëronautics, and so it very naturally and wisely appointed the previously existing governmental committee, the Advisory Committee for Aëronautics, as its committee representing this particular phase of activity.

The activities of that committee, with which I have had the pleasure of being associated since its formation, have naturally been very acute since the opening of hostilities, and in particular during the last few weeks. The activities of the committee have run along a number of different lines. Its fundamental duty is to advise any branch of the government on any subject which may have relation to aëronautic affairs. Naturally, at the present time, its activities are wholly restricted to the war requirements of the army and navy. It has nevertheless undertaken a number of secondary activities, or activities not directly related to what might at first thought be considered war activities, and yet none the less important. Thus, one piece of work which it has carried through is the clearing up of the patent situation, in order to ease up the condition of the industry which was threatened, as you may perhaps know, by strangulation as a result of certain patent claims. The expectation is that a form of cross-licensing arrangement will be developed as the result of the activities of our aëronautic committee, in a way very similar to the arrangement in the automobile trade. This is intended to secure an over-all cross-licensing arrangement whereby all patent rights and everything of the character will be pooled among the various companies involved, and will thus secure equal rights and claims with regard to the use of these various patents. A final meeting is expected on Tuesday next, at which it is hoped to make a definite arrangement with regard to this particular program.

Another activity with which the aëronautic committee has concerned itself is the question of insurance for aviators. It is obvious that in a general way an insurance company might be expected to look rather askance at the proposition of regular insurance for aviators. Nevertheless, it is equally clear

that the possibility of obtaining such insurance would be a very important factor in developing the necessary number of aviators. So for some months the committee has been concerning itself with developing among the various companies the possibilities for the definite writing of insurance, naturally at a somewhat increased premium, but writing insurance for aviators; and we are in a way now to have the arrangement developed and under way in a short time.

Likewise we have taken up the question of the possibility of accident insurance for aviators. This is under present discussion and consideration and will undoubtedly be merged with a somewhat broader development of the entire question of insurance under war conditions, which is being developed under the auspices of Mr. McAdoo, Secretary of the Treasury.

As a further phase of activity, this committee was instrumental in aiding the War Department in developing its system of so-called cadet aviator instruction, with reference to preliminary training of aviators for service in the army. Copying from the experience abroad, it was found desirable to pass those who were looking for active service in the aviation corps, through a certain preliminary training, not in the air but on the ground, which would cover, however, certain elementary instruction in the theory of aëroplanes, the theory and handling of internal combustion engines, some of the elements of photography as applied to aëroplane work; likewise some of the elementary instruction in handling machine guns, bombs, and work of that character, but in advance of going to the flying field and undertaking actual work in the air. At the present time there are eight educational institutions in the United States which are giving instruction of this sort. The idea has been to feed twenty-five cadets every week into these institutions and have them remain for eight weeks, and so have a continuous chain of educational activity grinding through, as it were, twenty-five men per week, so that when it is fully developed there will be twenty-five coming out each week and going thence to the training field. This matter is now entirely in the hands of the War Department, in charge of a special

officer who is giving his entire time to the oversight of this particular kind of training; but in the way of starting off this movement, getting together in conference college presidents or representatives who would be qualified to speak for their institutions and preparing the way for developing such training, the committee on aëronautics took the leading part.

Again, the committee on aëronautics is serving the needs of the War Department at the present time as a committee on inventions, and if there were time I am sure you would be entertained if I could give you an account of some of the startling inventions which are coming before our committee. It is of course to be expected that a large percentage—I will not undertake to say just how large—are quite hopeless. Viewed entirely as a problem in probabilities, it is not likely of course that a chance individual will develop something representing a distinct advance. I am perhaps fairly safe in saying that most of the inventions which come in are from untrained men, men trained in neither the science of engineering or the science of aëronautics, so that it is at least a long chance whether these men will be likely to develop anything which is really an advance in the state of the art, an art which now represents the residual of the scientific and engineering efforts which have marked the progress up to the present time. Nevertheless, we can not tell. That which seems foolish today may be the wisdom tomorrow. Our policy has been to receive any suggestion, no matter how foolish it may seem, at least to the extent of giving it a respectful hearing, looking it over and if it seems quite hopeless, to at least thank the author for sending it in.

Suggestions which come in in this way fall into certain classes, those which are obviously hopeless, those which are incomplete in presentation—but we make it an invariable rule to send them back and get full information before the suggestion is fully turned down—and those other suggestions which seem definitely to promise something of hope. Suggestions of the latter character are forwarded for research, test and development, and such treatment as may seem proper with ref-

erence to the particular problem in hand. At the present time, as you can readily believe, where such suggestions are coming in at the rate of fifty or more per day, a very considerable part of the activities of this particular committee are necessarily concerned with duties of this character.

Again, some of you have doubtless seen in the last few days references to a so-called all-America aëronautic engine, an engine which, yesterday for the first time, was visible at the Bureau of Standards, and which thirty days ago had no existence whatever. I may truly say it had no existence even in the brain of the designers. The construction of that engine as an entity in steel and structural material in thirty days from the time when it was first even talked about, is nothing less than a production miracle, an achievement which has never been approached in any degree before in this country or, I believe, in any country.

About a month ago two of the leading engineers of this country with reference to internal combustion engines and aircraft practice were put down together, sitting on a bed at the Willard Hotel with a piece of paper, and they were told, in the phraesology of the day, to "go to it" and develop the characteristics of an all-American aëronautic engine which should combine the best of everything known in this country and the best of everything available from abroad. I should perhaps say that a very considerable amount of information was thus available. At that time there had been brought from abroad the drawings or designs of the leading European countries France and England particularly, so that these designers had before them the best European practice, and of course they were perfectly familiar themselves with the best of American practice. So they sat down, as the story goes, on the bed with a scrap of paper between them, and talked over the characteristics of an all-America aëronautic engine. In a day or two the characteristics were pretty well decided upon. Immediately thereafter about two hundred draftsmen were mobilized over the country in eight or ten different organizations and put to work detailing these drawings. As soon as an individ-

ual item was complete in detail, it was placed in production, and ten engines were ordered purely as a preliminary try-out program.

I should say perhaps, in a little more detail, that the primary design of such an engine involves fundamentally the design of one cylinder, and its connected parts, and with such a design completed it is a matter of relative simplicity to combine four such cylinders into a four-cylinder engine, or eight cylinders into an eight-cylinder or twin-four and so on; so that this fundamental work provided thus for the development of four types of engines, of four, six, eight and twelve cylinders, varying from one hundred and thirty-five to about four hundred horsepower in capacity.

So these two hundred draftsmen over the country, working day and night without additional compensation, developed the details of this engine, and as soon as the details were completed they were put into production and five of the eight-cylinder type of engine and five of the twelve or twin-six type of engine were put through as one trial lot. It was undertaken at that time to show the first engine on the twenty-fifth of July. About the first of July the parts of the engine were all made and all ready to assemble in Detroit. It was first intended to bring the parts here and assemble them in the Bureau of Standards, but the people who were concerned with the manufacture of the engines were so anxious to see the thing in actual form, that finally the plans were changed to that degree and the engine was assembled in Detroit, shipped by special messengers—and if I had time it would be interesting to you to recount the experiences of those special messengers in rushing the engine through from one car to another, from one train to another—from Detroit to Washington within the shortest possible time.

The engine reached Washington two or three days ago, was set up, and has been on exhibition to the officers of the government and those concerned for the last two or three days. It is a beautiful piece of work, and it looks very much as though it ought to be very close to the final design of an all-American

winning aircraft engine. In weight it will compare very favorably with the best of foreign designs. These first engines, of course, are intended purely by way of try-out. It is not for a moment assumed that they represent the final, ultimate design. These engines will be tried out under adequate conditions, and on the basis of the results of the try-out, the final design will be perfected and they will be put into quantity production at the earliest possible moment. Just how soon these engines can be put into quantity production, of course I can not tell, but with the minimum time required to try out the engine we may at least look for that engine under quantity orders early in the fall; in other words, representing a performance in time of perhaps three months or some such matter between the first conception of the engine and the quantity orders under way in eight or ten different factories all over the country. The parts of that engine have been so carefully standardized that although this particular engine was made in twelve different factories, it came together without a hitch, without the necessity of using a file or any secondary agency whatever. This performance is, I believe, entirely without precedent, to manufacture an engine of so many hundreds of parts, in twelve different factories, and bring them together from all sections of the country, and have them match one with another in this flawless manner.

The development of this particular design is the work of the Aircraft Engineering Division of the Signal Corps working with the Committee on Aircraft Production, a committee appointed on the advice of the Advisory Committee for Aëronautics and intended to stand in immediate contact with the production capacity of the country.

Some months ago it was clearly seen that in the development of any munition of war, there is clearly indicated the military element, the scientific element, and the production element. We must recognize these three elements. The military element is naturally to be provided by the War Department or by the Navy Department, as the case may be. The National Advisory Committee for Aëronautics hopes that it may be able to con-

tribute the scientific element. In order to contribute the productive element, a special committee on aircraft production was appointed, operating in direct relation with the Council of National Defense and with Mr. Coffin, whom you all know, as the chairman of such committee.

So the work goes on. The problems are coming in from day to day, in one branch or another. We may never know in the morning what particular problem may present itself, whether something of a routine character or something which may represent a problem of the most fundamental and vital importance. One of the problems which has recently presented itself to the engineering committee is that of the development of body armor—an interesting reflection that we are in the way of going back to the days of chivalry when those who did battle were clothed with body armor of chain mail or steel plate.

Just now on my desk is a proposition to call to Washington, at an early date, a conference of those people who may be able to contribute most effectively to the study of the limitations and the possibilities of steel body armor. Such armor has already been used, and is being used in a limited way in Europe, and our own War Department has already placed or is in the way of placing an order for a limited number of sample suits or outfits of such body armor. But with a view to the improvement of such armor either in material or type or design, this conference has been suggested and will probably soon be called.

I have already used more time than I had intended in this quite discursive way, telling you somewhat of the activities of the Research Council as a whole, and in greater detail with regard to the activities of the Engineering Committee. We of the Engineering Committee, speaking for the engineers of the country, have made it very plain to the executive and administrative bodies of our government that the engineers of the country stand ready to the limit to serve the needs of the situation. They only desire to be shown wherein they may best serve, and the response will be immediate and full. With this

assurance on our part, we find a most cordial and hearty reception on the part of the government officials. If it were not perhaps that they are so overburdened with administrative matters of all sorts and characters, they might find more time to think over and develop the specific problems which could effectively be turned over to research bodies such as our own. It must be remembered that these governmental bureaus and bodies have not been accustomed to having thirty or forty thousand professional engineers at their service at a moment's notice. They have been accustomed to get along alone. They have been accustomed to doing by themselves, and as you know, they have developed their own splendid and effective engineering organizations. In many cases, perhaps, they have small need to come to us for the examination of problems in engineering or science. They have their own organizations. At present, however, these organizations are overburdened with work, and the energies and time of their officers are needed for duties more closely related to the military requirements of the situation. So while they realize thoroughly in principle the attitude of the engineers of the country and what it may mean to the study of their problems, it naturally takes some little time to adjust themselves to the idea that there are thirty or forty thousand engineers waiting and ready to be called. But this is a condition which may be expected to improve as time goes on, and the officers of the government acquire the habit of turning over problems of research and investigation to the Research Council for investigation and study.

The development of this relation of understanding and cooperation between the executive branches of the government and the engineers of the country is something which we shall all hope will continue beyond the limits of the present conditions of war stress on into times of peace as a permanent means of service on our part to the scientific and engineering needs of the government.

J. W. Dietz: The Western Electric Company, in common with companies employing technical men, is up against it, of course. We can not get all the men that we need. We have

not all the men we need now. The question, as I understand it, is, what are we going to do today? The Western Electric Company has established and has had working for a number of years in its organization what we call an educational system. We try to discover within our own employ, among our own people, such talent as we have and to develop it as fully as possible through the natural avenues of employment, which can be supplemented by our own instruction, and through coöperative instruction with other educational agencies.

Our work divides itself broadly into three kinds—engineering, manufacturing, and distribution or commercial work. Each of these three organizations has its educational advisory committee, made up of executives who are in touch with the everyday needs of the work of their departments, who have the ear of the highest executives and officials of the company and are close enough to the men to know them personally. It is into the hands of such advisory committees that we entrust the plan for the development of our personnel.

From these three supplementary advisory committees, representing the three main branches of our organization, we select a company educational organization, which blocks out and defines and initiates the educational policies of the company as a whole. So we feel that we have plans for discovering and developing our talent from within. That means that we have plans for taking the office boy and carefully training him in his first tasks, watching him and guiding him properly into the next higher step.

Our problem regarding the college men will have to be met in the same way and in the same spirit. We are actively, under our eductional organization, making search now for high school graduates, who have already been in our organization for three or four years, boys who came with us directly from the high school, who now are twenty-one or twenty-two years of age. With those boys we shall try to work in a way that they might develop and undertake some tasks which we have formerly assigned to college men as beginner's jobs.

We have gone to some of the women's colleges for young women who are specially interested in physics and mathematics, and a number of those are entering our laboratories for work there. I believe there is a distinct place for the trained young woman who has taste and aptitude for that type of work in the spirit of research and investigation that prevails in our laboratories.

The plan which I have told you regarding the Western Electric Company I think is typical in a way of many of the plans which are being followed by large industries throughout the country. There is an association of such employers known as the National Association of Corporation Schools, composed of companies who have the viewpoint of trying to make employment a distinct educational means, recognizing that we must take our people where you folks leave off, and do a lot of specialization and intensification of their training within our own plants. We believe there will be a wholesome reaction as we get more employers to take that point of view, and I am glad that the expressions here have indicated that that already is the tendency. If you feel that it is your job to lay a splendid foundation of the fundamentals, then it is up to us to build upon that foundation, and we believe it will be a much easier job to develop broad and useful engineers on that type of foundation than it is now, taking a man who specializes too soon. These are reactions that we believe will work out broadly in the long run.

There is just one other point which I have to bring before you: This National Association of Corporation Schools has a committee known as the committee on technical and executive training. Last year it gathered information from our members—they number over one hundred companies, employing over three hundred thousand people—and found that had conditions been normal, last June we would have employed about a thousand college graduates, most of them engineering graduates. Of course we all fell very much short of that estimate. We also in that report brought out that the companies can and are trying to promptly adapt the recent college graduate

to the work of the different organizations. We believe that that sort of information is of interest to all of you people. We believe, too, that there ought to be more active coöperation between this Society and such an organization of employers. I think the Association of Corporation Schools is unique, because it represents coöperative effort of employers, many of them in competing lines, who have worked together on this basis because they all recognize that employment, or the dealing with the human element in business, is a common problem and a very vital one. Human nature is much the same, whether you bundle it up into an organization and call it a society, a town, or call it the Westinghouse Electric or the Western Electric or the American Bridge Company. The fundamental problems we found were worth undertaking and investigating together. We believe in this matter of the employment of college men, we ought to be getting together on a very frank basis. Some of you folks who have entertained perhaps twenty-five or thirty representatives of different companies at your schools in the last few months may feel that really after all the employment of men is a kind of nuisance. Are there not some points of common interest on which we might get together—for instance, standardization of information to prospective employers, methods of getting in touch with the records that men make at college? Can we not agree on some good way, and let us try to do it in that way? Following the progress of your graduates is another point and, too, the important problem of vacation employment. These are some of the sorts of things that we have in mind.

If you will appoint two or three of your good live members to get together with us, we would enjoy working with them on some of these problems of mutual interest. If a group of competing employers can get together, certainly, with you who are training men for industry and we of the industries needing them, we ought to have a point of contact that would be very helpful to both. I hope, if it is proper at this time, we may have some further discussion of that suggestion, to get the viewpoint of the college people.

A. L. Rohrer: I will take just a minute of your time to say what is in my mind. You have heard, both yesterday and today, very interesting details as to the activities of the government in this war situation. Perhaps for the first time, we have had an expression from representatives of various governmental bodies, of their sincere appreciation of the engineer in the work he has done and is doing for them in this time of great stress. To me this has been most interesting, because it has relieved my mind to know that some definite things are being accomplished by the government. Somehow or other I have had the impression that with the tendency towards over-organization, as evidenced by the numerous committees, councils and commissions which have been appointed, not much would come of it. Evidently the lack of authority, which is usually fatal to progress in the industries, has not interfered very much with progress here in Washington.

While the statements were being made concerning certain specific activities in which the engineer and the technical man have played such an important part, parallel situations came to my mind as to what has been going on in industrial work for the past thirty years or more. Under commercial stress we have had to do some things in this same way, and great progress was the result. One of the last speakers gave a specific case of rapid production wherein the parts of an important piece of apparatus were designed, built and assembled in less than thirty days. I know of a number of instances that have come in my own experience, which were carried out along the same general lines, and this could not have been accomplished without the engineer. That is why industrial corporations appreciate the engineer. We want him to design, to assist in shop production, to assist the sales organization, and, perhaps most of all, we need him in research work. That is why for the past twenty years I have been coming to your institutions and helping you select some of your graduates that have been brought into the organization of the General Electric Company, and some of them were trained for its customers. At my request, I have recently been relieved of this particular

duty, which has been most enjoyable because of the very pleasant association with this Society and with many of its members whom I count as my personal friends.

As research work is most important to our government just now, so it has been important to the industries. The corporation with which I am associated has carried it on all these years in some form or other until several years ago, when it crystallized itself into the organization of that great Research Laboratory at Schenectady, with Dr. Whitney as its director and Professor Elihu Thomson and other engineers as its advisory council. The industries have needed all these years the product you men have been turning out in the college and in the university, and we need them today perhaps more than at any other time, because of the great strain on production. "Busy" is the word that very mildly expresses the situation. We are called upon to make rapid increases; the customer wants the product sooner than it can be rushed through, and the space between the time the order is placed and the time of delivery is stretching out further and further.

In view of what I have said and what others have said, I do not blame you if you all go home feeling somewhat "chesty" from the fact that you have produced material that is so useful to the government and to the industries at large.

Mr. Reed: I had hardly expected to say anything, because our company does not need many men from the technical schools. We do get them and so far we have been getting as many as we have needed, about five or six a year. We have had, however, another problem that has not been mentioned here, that might be worth your consideration, and that is the training of the man lower down, the man to go right into the shop. There has been no mention here of your teaching of shop practice. We have found that the little thorough knowledge of shop practice obtained in technical schools is sufficient for the training of these young boys in shop practice. If there is any tendency that this war will change, it is to accelerate the period that it will take a technical graduate to work into an industry and to be able to train these younger

boys, and possibly the women that we may have to put into our industries. I think there is a field there that has not been mentioned, in which the technical graduate may be very useful —the training of the newcomers in industry.

C. R. Dooley: Professor Bird said today that he was not teaching chemistry, but rather employing chemistry as a means of teaching young men to think. From our point of view, that is exactly what we want—men trained to think. We care not whether that training has been in electrical, mechanical, chemical or civil subjects. We do not expect students to come loaded down with information in catalog form, but we do like them trained in power of analysis and original thinking. In most of our teaching work we have followed that method, and I can say from our experience that it works. For example, it is quite usual to teach mechanical drawing by carefully describing the principle of first and third angle projection, then explaining the feature of the two standard triangles, then how to sharpen a pencil, hold the pen, use the T-square, etc. By and by, when he has learned his tools, he is given some simple problem to work. Our students get a problem to work out on the drawing board for their first lesson, and in the working out of this problem they learn to tell a mechanical story by flat picture and to use their tools, of course, under the direction of the instructor. The ink bottle and the blue print paper have nothing to do with the basic intelligence required for drafting—a fact many instructors never seem to get.

The development in this method of teaching is far more important than curricula or schedules.

In the present time of need no man is more anxious to serve his country than the engineering graduate. He is somewhat at a loss to know his best way. Washington has given out only a general statement that each man should serve in that field for which he is best qualified. We employed this winter one hundred and sixty-seven graduates. Since the time of employment I think between thirty-five and forty have asked to be relieved so they could take up some military duty. We

have pointed out to them that this war is, as Secretary Baker said this morning, a war of scientists, and that men will be needed in the industries just as badly as they will at the front. We believe that such industries as ours are going to be vital to the winning of this war, and we believe it is a patriotic act for young engineers to take up the job for which they have been trained. I am glad to say that about one hundred and ten out of one hundred and sixty have or will, within a month, reported for duty.

When school opens in the fall, I hope you will make it your business to study the situation carefully and encourage the students—at least the most promising ones—to stick to their training, because the war industries need them.

I have just heard that the president of one of our large middle western universities, at a public gathering of the students, made this statement: "What a fine thing it would be if our student body were entirely depleted by students enlisting to go to the trenches." Another school in the East graduated the entire class with no interruption of work, upholding the importance of engineering work. I believe the latter was better judgment.

Mr. Dietz made a suggestion a moment ago for coöperation between this Society and the National Association for Corporation Schools. There are a number of points on which coöperation would be a fine thing. I will mention just one. When I dropped into Cornell to see how many students would like to try their luck with us, I was the twenty-seventh man who had been there looking for students. I am sure if I were a student and had to interview twenty-seven prospective employers, I would be somewhat bewildered. The interview, the selection, and the placing before each student the opportunities in the lines of work of the different companies, are matters in which we could profitably coöperate. If this Society had a commitee which could find a way to work with the committee which the Corporation Society has, it would tend toward a solution of the problem of proper vocational guidance of the graduates.

A. A. Potter: It seems to me the matter of coöperation between the members of this Society and the companies who are employing our graduates is of importance at all times. It is most fitting that this Society should take cognizance of this fact and appoint a committee or give that authority to the Council, so that coöperation may be had between the Society for the Promotion of Engineering Education and the National Association of Corporation Schools. Therefore I move you, Mr. President, that the Committee on Committees of this Society be directed to have such a committee appointed.

(The motion was duly seconded and unanimously carried.)

H. Wade Hibbard: There is a concrete case that took place before we declared war, when a very large manufacturing concern, with a large and very excellent organization, took a contract for the manufacture of an enormous quantity of shrapnel. They thought the thing over and found that they did not know how to go at it. The job was something strange. They had in their company a group of young technical graduates that had been out of college only two or three years. They put this job up to that little group, and those young men, not men of a lot of experience, but men that had a quality that bigger men in that company did not appear to have—adaptability and pliability that enabled them to tackle that job of how they could get out that big contract in the best way—studied the problem, outlined it, planned the work, planned the organization, detailed the work; and made a thorough success of the manufacture of the shells for that company. I know this from one of the higher officials of the company.

This incident leads me to say that I hope we, as engineering professors, shall encourage these young fellows—that while they should be humble, they should not be too humble, and they should recognize in themselves that they have a freshness of outlook that may enable them in the industries, now that we have gone into the war, to make successes of the manufacture of the various arms and munitions.

REPORT OF JOINT COMMITTEE ON ENGINEERING EDUCATION.

BY DR. C. R. MANN.

The entire year just past has been devoted to working the materials gathered for this report into final form. The historical method of presenting the subject, which I have described to this Society twice already, has been abandoned in the belief that it is not as effective a presentation for engineers as a more direct description of present conditions and the problems that they define. Therefore, the report has been entirely rewritten since last Christmas. At present the schedule calls for fourteen chapters. Twelve of them are completed; the other two are under way, and I hope to have the writing finished in a few weeks, so that the copy may go to the printer before the end of the summer. It will probably be issued in final form some time early in the fall.

It is impossible to describe fully the contents of this report in the half-hour we have here this morning, because, as you know, it attempts to define the meaning of engineering, not only for the present but also for the future. It is essential, of course, for the schools, if they are to prepare engineers for this country for the next generation, to know what sort of policy is the wise policy to select with reference to the coming years. Therefore, the chief difficulty that has been experienced has arisen from the effort to determine what is the trend of development of engineering as a science and what are the probabilities of its development in the future, in order to suggest to the schools lines of development that might seem fruitful for experiment.

The report contains no specific recommendations. It does not say: "Thus and thus shall you do." It calls attention to conditions as they exist at the present time, tries to analyze

those conditions and get their meaning, and points out a number of experiments that are under way in the schools and in the industries which indicate the trend of development. Then follows a series of questions which are intended to focus the problem. If the schools will study those questions carefully and in an experimental way, they will discover for themselves lines of fruitful development.

The report is divided into three main sections. The first section deals primarily with the present situation, the second section with the special subjects of instruction while the third is devoted to the question of objective tests.

The first chapter presents general conditions such as the fact that there are 125 schools that give bachelors' degrees in engineering. These schools are roughly classified into schools that are independent and devote themselves entirely to engineering schools that are connected with universities, the land-grant colleges, and so on. Attention is called to the rapid development of the schools. Thirty years ago, benefactions to education in this country were being made at the rate of about five million dollars a year. Within the past ten years, benefactions have been made at the average rate of thirty-five million dollars a year. The mere physical growth of the engineering schools, colleges, and universities has been so rapid that the attention of the presidents and the administrative officers and faculty has been almost of necessity occupied with the administrative details of organizing and reorganizing and building up this enormous new school system. This defines the type of information in the first chapter.

The second chapter deals with the growth of the curriculum. The first engineering school, Rensselaer, was intended to be modeled after the Fellenberg school at Hofwyl, Switzerland. When the New York State legislature refused to establish such a school, Mr. Rensselaer founded it for the purpose of training teachers for the public schools of New York in order to educate the farmers and mechanics of the country to be better farmers and better mechanics. The first term of the

school was a laboratory term. The boys visited the industries and agriculture near the school,—studied the things in the field first,—and then reported on them in school. The problems studied in the classroom were derived from the studies in the field. This method of instruction lasted only two or three years. It was found to be much more expensive to teach students in that way than to teach them in the ordinary way; and therefore in 1829 the method was inverted. The theory was taught first, and the practical applications in the vicinity were studied afterward.

The 1829 curriculum lasted until 1850, when President B. Franklin Greene went to France and on his return reorganized the curriculum into a three-year curriculum, modeled largely after the French schools. That curriculum is practically, with very moderate changes, still in force in the engineering schools.

The other important contribution to the curriculum was made by the Massachusetts Institute of Technology in 1865. A comparison of the Massachusetts curriculum with the Rensselaer curriculum shows that in the main outlines they are constructed on the same general conception; namely, that engineering is applied science, and that in order to apply science we must first know science; and therefore we must teach the science first and then teach the application of that science.

In the fifty years that have passed the changes in the curriculum have consisted in pushing forward toward the high school some of the subjects which were formerly taught in college. There has also been a gradual drifting toward the earlier years of the drawing and the descriptive geometry. Mechanics and physics have come down into the second year, sometimes into the first year. But while there has been a drift toward the first years of the curriculum, the general principle on which engineering curricula are constructed has remained practically the same.

There has also been a very marked specialization in the technical work. The number of studies which a student

carries at the present time is very much larger than it was fifty years ago. The older curricula have three, four, sometimes five studies at a given time; and at present, as you know, it is not unusual to find curricula with nine, ten, eleven, and even thirteen subjects running at the same time. The division of the time of the curriculum between the humanities, the sciences and the technical work, has changed somewhat. In the older curriculum forty-one per cent. of the time was devoted to technical work. The average for all the 125 schools is at present fifty-two per cent. In the case of the humanities, in the early years, it was twenty-seven per cent., now it is nineteen. The sciences have also fallen from thirty-two to twenty-nine per cent. At present, in the schools studied, the average division of time is now about twenty per cent. to humanities, thirty per cent. to mathematics and sciences, and fifty per cent., roughly, to technical work.

The chapter on the curriculum closes with a statement of the purposes of the curriculum, as made by President Rogers, of the Massachusetts Institute. President Rogers gave us perhaps the most lucid and far-seeing and remarkable definition of what technical education was that has yet been published in this country. His pamphlet on the Objects and Plan of an Institute of Technology in Boston is one of the educational classics of this country, and ought to be studied very carefully. The main argument in this pamphlet is this: Material prosperity and intellectual advancement are inseparably associated. Material prosperity depends upon industrial production. The function of the engineering school is to supply the intellectual element in production. The intellectual element in production consists of knowledge of science. Therefore, the function of the engineering school is to teach science, the principles of science, and the means of applying science; and in that way it best supplies the intellectual element in production.

The important point to note is that according to President Rogers, the function of the school is to increase production. The situation today, in the light of that fact, is rather strik-

ing. It is safe to say that at the present time, fifty years after the foundation of these schools, less than five per cent. of the production managers in this country have received a technical training. That is, the engineering schools have been supplying the designers, administrators, managers of transportation, managers of distribution; but the actual manager of production, the man who is responsible for seeing that the shop delivers the goods properly finished and on time, is at present still in almost all cases a shop-trained man.

The chapter on curriculum ends with a question as to whether the conception that the way to supply the intellectual element in production is first to teach science and then to show how to apply it is the best that can be found; or whether the original effort of Rensselaer to study production first, and then in connection with the study of production to work out the science, is not worth trying even at the present time.

The third chapter deals with the student. This can be dismissed rather briefly, because much of this material has already been presented to this Society. The large elimination of students and the significance of low grades amongst graduates have already been discussed here. The important question raised is whether the present system of handling students is the one that inspires them to maximum effort. The question of the marking system both as a means of measuring student performance, and as an incentive to maximum effort is discussed at length. There is no question that a person is best incited to maximum effort by proper appreciation, and particularly by the feeling that his work is being fairly and rationally measured, and that the grading is an objective and impersonal determination of his real achievement. For the schools the question is whether they cannot, by study, and an effort to get more impersonal and objective measures of student achievement, incite a student to greater achievement; and whether they do not have in this a very powerful method of releasing his creative energy and starting him to want to do the things that we want him to do on his own steam rather than under compulsion.

The fourth chapter deals with faculty organization. It is here pointed out that faculties and administrative officers have been of necessity overwhelmed by the enormous physical growth of schools in number of students, in endowment, in financial responsibility, etc. Therefore attention has not yet been directed sufficiently towards educational problems. As a result, there are almost as many types of faculty organization as there are schools. These may, however, be grouped roughly in three groups: namely, first, the military type, which needs no further definition, perhaps, than that the organization is controlled by one individual. Second, the independent or autonomous department type, in which every department is an independent unit, and in which these independent units control the curriculum and its administration by faculty vote. Third, the coöperative type, in which departmental autonomy is not recognized, but the form and content of every course in every department are treated as the business of the entire school.

There are relatively few administrative systems of the military type at present; the great majority of schools are organized on the independent department plan. At the present time there are also relatively few of the coöperative type. Which of these types of administration produces the best conditions for developing the members of the faculty by furnishing the most effective incentives for maximum output? Here the universities have already recognized that the central problem is that of liberating the spirit of investigation. The most effective organization is the one that best fosters the research spirit. Hitherto the autonomous department system has worked effectively in developing research along highly specialized scientific lines. Perhaps the utter independence of the department has been necessary in physics, for instance, to develop the best research in physics. But now science has so covered all fields of thought that its problems can no longer be limited within departmental barriers. Hence, when the idea of research is confined to scientific research in specialized lines, we put a damper on a great deal of research ability in

the faculty which would like to express itself in studying industrial problems, in studying social problems, or in studying educational problems. This damper may be removed by expanding the range of research far beyond the limits of material nature and the laws of material nature. Research in economics, in sociology, in industry, and particularly in education, must be recognized as being as valid an expression of the spirit of investigation as is research in natural science. The faculty organization that permits the maximum release of the spirit of investigation seems to be the coöperative type, where the members of the various departments have become liberal enough to see that the particular management of their own courses is not a matter for the department alone, but is a question for the whole school to consider.

The fifth chapter deals with the demands of the engineering profession. This topic has been given wide publicity through the letters which were sent to the engineering societies and to professional engineers. Here an effort is made to interpret the meaning of the statement that character, judgment, efficiency, etc., were as important or more important to the professional engineer than knowledge of the science and the technique of engineering. The main argument is this:

Since the aim of all engineering is intelligent production, the function of the engineering school is to develop men for intelligent production. The factors of production at the present time are men, materials, and organization; and each of those factors has to be considered in every engineering project from the point of view of science, of practice, and of costs. That is, we must first consider whether a structure is scientifically possible; second, if it is scientifically correct, can it be built; and third, is the value to be obtained from the structure worth the cost?

In solving an engineering problem science is absolutely essential. A structure cannot be properly designed without knowledge of science. An understanding of shop practice is also absolutely essential. A scientifically correct structure that cannot be built is useless. But the controlling factor in

production is the question of the appraisement of values and costs. Somebody must decide that the value to be obtained from a structure warrants the cost of producing it. Somebody has to be willing to pay the price, or the structure will not be built. Hence, the controlling element in production,—the act that determines whether science and application shall serve men,—is the appraisement of values and costs.

In engineering schools at present, the question of materials is treated very fully from the points of view of science and of practice. The students learn the properties of materials, and the laws of science with a reasonable degree of success. But the appraisement of values and costs, which is the controlling element, is treated slightingly. Some schools ignore it altogether, while in others it is recognized to a certain extent, but nowhere does it receive anything like the emphasis and importance which it has in real life. It is the controlling element in engineering, and it is not so treated in the schools. To make the school true to life, the appraisement of values and costs must be included in all of the instruction much more fully than is done at the present time.

In introducing the appraisement of values and costs into school work it is important, however, not to limit the conception of values and costs to monetary values and costs. Such a limitation would justify the charge which the academic colleges make that engineering begets ideals of the market-place and serves only the mighty dollar. For this question of the appraisement of values and costs is, after all, the really vital question in every problem in life. The ultimate question in art or in esthetics or in morals or in anything else is whether the game is worth the candle, which is the question of values and costs. Hence, the problem of values and costs, in all its range from money to morals, is the vital element in every real situation. By analyzing all engineering projects that are treated in the schools from the viewpoint of values and costs, it is possible to open the flood-gates of real life to the student. To do this completely it is necessary also to make the student

feel that the work he is doing today in this laboratory has a value to him that is worth the cost to him.

It thus appears that appraisement of values and costs is the governing power in engineering. It is also the governing power in education. For when a boy really feels that the game is worth the candle, he works with zeal and enthusiasm. These are the conditions favorable to the development of character, judgment, efficiency, and the understanding of men. These are also the most favorable conditions for rapid mastery of skill and technique. Hence the infusion of adequate consideration of values and costs into the technical work offers a key to the educational problem defined by the professional demand for the development of character, judgment, efficiency, and understanding of men along with proficiency in the science and the technique of engineering. To be fully successful too limited a conception must not be held of the meaning of values and costs. In his well-known book on "Work and Wealth," Hobson, the English economist, has analyzed the problems of economics from the point of view of human wealth. This book defines as well as anything I know the larger meaning of the appraisement of values and costs in human life. The inclusion of these ideals in the work in engineering schools also answers the demand for broadminded and humanistic men; because a true appreciation of values and costs is the real basis of humanism. Since it is impossible to make so intricate a situation clear in a few words, reference must be made to the full argument in the report.

From this point of view the chief problem of technical education is that of finding effective ways and means of including the appraisement of values and costs in technical courses. Therefore, the second part of the report deals with methods of doing this in the various special subjects of the curriculum. The special subjects selected for treatment are, first, English; second, mathematics; third, chemistry; fourth, physics; fifth, mechanics; sixth, drawing; seventh, shop work; and, finally, the technical courses. The final chapter contains a summary and recommendations. A separate chapter is given to each of

the subjects English, mathematics, chemistry, physics, mechanics, shop work, and drawing, and only one chapter to the technical courses, because these subjects are the fundamentals that the engineers are so insistent shall be mastered. If the educational principles involved in these special subjects are clear, they will be perfectly clear for the technical branches. Manifestly it would be wholly out of place for any one individual to make any specific recommendations as to the contents of the course in civil engineering, for instance. Only a group of specialists can do that. It is, however, possible to indicate the educational methods which seem to be most fruitful in teaching any particular subject in civil engineering or mechanical engineering to students so that they may receive maximum benefit.

There is no time left now for the details of these chapters on the special subjects. They indicate what types of work are being given in the different schools, and point out what experiments indicate a desire to change. An effort is then made to interpret those experiments and discover the trend they indicate. Throughout the entire discussion the attitude is maintained that we do not any of us know at the present time how to teach any of these things. Emphasis is continually placed on the fact that our ignorance on questions of teaching is very vast, that the only way we will ever find out how to teach is by experiment, and that experiments do not succeed in convincing people on educational questions unless the results are measured by objective tests and impersonal scales. For instance, a very interesting experiment in mechanics is being made at the University of Washington. The experiment has been so successful with one section of freshman engineers that next year it will be tried for the entire engineering class. But while it has succeeded in convincing the men there of its validity, those of us who are teaching mechanics, and just read about it, are utterly unconvinced, because the judgment of the success of the experiment is very largely a subjective matter. There are no objective tests that we all understand; there are no scales of achievement in mechanics which we all

comprehend. Therefore the results of an experiment like this have very little effect in changing the teaching of mechanics, for the reason that they are not expressible at the present time in a terminology that we all understand. Similarly, Professor Schlichter is making a very interesting experiment in mathematics; but he does not convince many of us that his method is a better method of teaching mathematics. Why? Because there are no scales of achievement in mathematics or of mathematical ability which are universally understood and accepted, and therefore he cannot make clear and prove his case in such a way that we all accept it.

The conclusion of this discussion is that we need experiment. Above all we need objective methods of measuring results, so that we can tell "where we are at." Hence, the last section of the report is an investigation by Professor Thorndike, of Columbia University, on the question of the validity of objective tests, and the types of test that are objective. Professor Thorndike has made a number of experiments with freshmen at Columbia, Massachusetts Institute, Wentworth Institute, and the University of Cincinnati, as to the types of tests that might be used in admitting freshmen and in determining whether they have the characteristics that enable them to do engineering work satisfactorily. He has also made, through the courtesy of the Westinghouse Company, a series of tests at the Westinghouse plant upon the young men who are there taking the apprentice course for the college graduates. The third section presents the details of what was done, and what results were achieved. This third section describes a method of beginning the investigation of this question of tests which I am thoroughly convinced is valid. Please do not understand that these tests are valid. They are valid within certain limits, and Professor Thorndike tells us how valid they are, and how much reliance you can place on them. These experiments simply open the way and point out a line of development which with further investigation and study will lead to better means than we now have of finding out how successful we are with different methods of teaching.

The report closes with the plea that others will experiment with these tests, and that others will try experiments in teaching, and that we use meetings of this sort for a critical discussion of the results of experiments. Why should not a meeting of this sort be like the meetings of the scientific societies, where men present the results they have achieved, provided educational results could be stated in objective terms that all can understand?

There is one other plea for objective tests. An objective measure of achievement is a very valid form of incentive. The hundred-yard dash in ten seconds is a very valid incentive to the boy to beat the record if he can. An objective measurement of teaching, where you can show and convince the teacher exactly how well his class did last year, and how well they did this year under a different treatment, is an equally valid incentive to the teacher. That method has not yet been used seriously in releasing the spirit of investigation among teachers; but it is a very effective means of awakening the research spirit and, therefore, of liberating creative energy.

REPORT OF COMMITTEE ON ADMINISTRATION.

This is a comittee of which I happen to be the chairman. I shall have a similar report to make—that is to say, after a conference with the former chairman, Professor Constant of Princeton, whom I met in Philadelphia for the purpose, a questionnaire was drawn up and submitted to the members and to the secretary. The secretary promptly replied with the suggestion that the number of questions be largely reduced. One by one replies dropped in from other members of the committee, and many of them were of the same tenor, some expressing some doubt as to whether questionnaires were very fruitful means of investigation. While I was waiting for those replies and getting ready to send out an abridged questionnaire to meet the views of the committee, came the war, and that perhaps changed entirely the complexion of the meeting and changed the place, so it seemed best to me to postpone any formal report on any action on the material that had been collected already, until a time when the Society could be brought back to a consideration of questions normally present before it.

REPORT OF COMMITTEE ON ADMISSION.

I simply want to state to the members of the Society that the Committee on Admission has nothing to report at this meeting except that the material is together, we are ready to go to work on the report, and hope to get it out in the very near future.

REPORT OF COMMITTEE ON ENGLISH.

Committee: Samuel C. Earle, Chairman, Tufts College, Mass.; J. M. Telleen, Case School of Applied Science, Cleveland, Ohio; Frank Aydelotte, Massachusetts Institute of Technology, Cambridge, Mass.; C. F. Parks, Massachusetts Institute of Technology, Cambridge, Mass.; C. W. Park, University of Cincinnati, Cincinnati, Ohio; C. A. Smith, University of Virginia, University, Virginia.

The work of Committee No. 12 for 1917 is chiefly transitional and preparatory. A survey of the "present status of the teaching of English to engineering students," made in 1916, indicated that before a detailed outline of methods could be recommended it would be necessary to collect further data on the organization of English instruction in the various colleges. In some cases, it appeared, the problem had not been given sufficient study to warrant a definite statement. In many others, although the condition of English work was reported as satisfactory, details were lacking in the replies. From a number of institutions, of course, complete returns were received, including much valuable material which the Committee will later place at the disposal of all who are interested in the improvement of English teaching. In order to supplement this material with further contributions and to prepare for a detailed report to be submitted in 1918, the committee sent out the following appeal:

The Committee on English of the Society spent its first year informing itself as to the "present status of the teaching of English to engineering students," and planned to formulate suggestions during its second year as to methods of instruction; but the preliminary investigation disclosed such radical differences in conception of what "English" means and of its proper place in engineering schools, that the committee

decided to devote its second year to a consideration of "Attitudes Toward English."

Some materials have already been collected, but it seems to be difficult to get those who could make most valuable contributions to reduce their "attitudes" to writing; consequently an article entitled "Institutional Instruction in English" was published in the February issue of the BULLETIN of the Society for the purpose of stirring up and defining discussion. It should be noted that this article is simply the attitude of a single member of the committee, and it is hoped that it will call out the expression of many and varied attitudes.

After a study of all the returns obtainable, the committee will make report to the Society in time for discussion at its annual meeting in June.

You would be assisting toward the solution of difficult—and we believe important—educational problems, if you would send to any member of the committee your personal attitude on one or more of the points suggested. In order that the committee may get its report in shape for publication, according to requirement, before the annual meeting, replies should be received before April 1. If you should give editorial (or otherwise printed) consideration to the subject, it would save possible oversight if you would send the committee a copy or at least a reference.

A summary of the recent returns will be presented at the annual session of the Society. The preliminary digest of material given below will indicate some of the principal topics for discussion at the June meeting.

ATTITUDES OF TEACHERS OF ENGLISH.

The summary of opinion given below is based not only on material specifically prepared for Committee No. 12 within the past two years, but also on printed statements which have appeared during the same period. The purpose of this compilation, as I understand it, is to indicate the general opinion

of teachers of English, as to the kind of instruction that should be given to engineering students, and the aim that such instruction should have. Unanimity of opinion was not, of course, to be expected—or for that matter, to be desired. It was felt, however, that the presentation of typical statements of the policy and philosophy of English departments would bring the committee a step nearer to the formulation of definite recommendations as to policy and methods, to be embodied in their report for 1918.

A hopeful sign of the times is that English instructors are coming more and more to analyze their problems on the practical basis of what is expected of them and what they can reasonably hope to accomplish. In addition to the question, "What do we English teachers prefer to teach?" they are asking, "What do the students need to fit them for the future, both as technicians and as cultivated men?" In other words, the student's English instruction is coming to be looked upon, not as an exclusively departmental matter, but as a part of an entire course, which covers a period of years, includes a wide range of correlated subjects, and leads to a single, definite result: the all-round training of an engineer.

For convenient reference, the principal aims suggested by teachers of English are given below, together with subdivisions indicating the kind of instruction recommended. If space permitted, I should like to quote at length from the replies, but in this preliminary report, only a general summary can be given. I have taken the liberty to make some changes in the phrasing, but only in order to give uniformity to the series. The divisions range in general from compulsory to elective work in English, or in other words, from what is regarded as indispensable to what is considered merely desirable. The distinction between a necessity and a luxury, however, is not easier to draw in education than in other fields, and emphasis naturally varies with different instructors reporting. A referendum on the order of importance for these divisions and

on the relative amounts of time to be given them should make an interesting section of the committee's report for 1918.

1. *English as a guarantee against illiteracy among college graduates.*

(*a*) Typist English: review of elementary grammatical and mechanical forms, to make up for inadequate preparation of entering students.

(*b*) A constant check upon the writing of students during their course, in order to cultivate habitual correctness of form.

(*c*) Heavy penalties for mistakes, and refusal of degrees to incorrigible illiterates.

(*d*) Reading and study of literature, especially the classics, chiefly for the sake of familiarity with what educated people are expected to know.

(It will be noted that this division is intended to protect the reputation of the institution as much as to aid the student. It will also be evident that (*b*) and (*c*) require the coöperation of technical departments.)

2. *English as training in thinking.*

(*a*) Rigorous drill in exposition, especially in definition and analysis.

(*b*) Briefing and writing of argumentative compositions.

(*c*) Developing the student's constructive imagination. (See Professor C. A. Smith's recommendations.)

3. *English as a tool for use in technical work during and after the college course.*

(*a*) Note taking.

(*b*) Writing of reports.

(*c*) Writing of technical papers for student societies.

(*d*) Writing and criticism of technical articles.

(*e*) Writing of business letters.

(*f*) Oral presentation of technical matter, including both prepared and impromptu speeches.

4. *English as a groundwork for effective expression.*

(*a*) Reading and study of masterpieces of English literature, in order that their literary quality and technical excellence may influence the student's own style.

5. *English as a link between the professional and the human interests of the student.*

(*a*) Reading and writing of essays interpreting the work of the engineer and explaining the larger meaning of his industrial environment.

(*b*) Reading and criticism of contemporary fiction and poetry which express the spirit of the age.

6. *English as a cultural and recreational escape from the monotonous literalism of vocational study.*

(*a*) Literature studied as literature, with emphasis on its aesthetic values.

(*b*) Reading for the sake of enjoyment, diversion, appreciation. (Far from attempting to show the connection between literature and the engineer's vocation, this type of instruction demands that he forget his profession entirely for the time being and lose himself in a totally different atmosphere.)

Respectfully submitted,

C. W. PARK.

UNIVERSITY OF CINCINNATI.

DEVELOPING THE STUDENT'S CONSTRUCTIVE IMAGINATION.

I have only three suggestions to make, one negative and two positive.

First, the emphasis should not be put on the history of literature or on biographical details. These things do not constitute literature; they are only the fringes of literature. You can no more teach literature by teaching the history of literature than you can teach botany or geometry by teaching the lives of the great botanists or geometricians.

Second, the teacher of English should coöperate with the departments of engineering by facilitating the student's mastery of the new words and phrases that he is sure to encounter. Let the English teacher have upon his shelves some of the leading books out of which the student is to learn engineering. Let him familiarize himself to a degree with the special vocabulary of these books and endeavor to add them as far as pos-

sible to the student's working vocabulary. Many of these words express ideas that can be made to do service by analogy or contrast in other departments than those of engineering. Try to widen the student's vocabulary by showing him how useful these words are when applied to problems of literature, sociology, politics, or economics. Do not mind a little humor here. It will tighten the student's grip on an engineering term if he can apply it cleverly in a new realm of thought, however strained or exaggerated the application may be. Draw up a list of some of the more expressive engineering terms and assign as a written exercise the use of these terms in the discussion of a non-engineering subject. Such a discipline will give the student a freedom and ease and mastery in the use of words and especially of new words that he can hardly get otherwise.

Third, the teacher of English should coöperate with the departments of engineering not only in the matter of words but by training the student's constructive imagination. It is here that literature and engineering find a common meeting place, a common interest, a common storage battery. "Between the creative imagination and rational investigation," says Ribot, "there is a community of nature: both presuppose the ability of seizing upon likenesses." When Lord Kelvin died, the London *Times* said of him: "His siphon-recorder, his compass, and his electrometers are instances of that thoroughness, alike in conception and execution, which marked his work. It flowed from that highest of intellectual qualities, the constructive scientific imagination, which 'bodies forth the forms of things unknown' with such definition and precision that the mechanical faculties work up to the conception as to a visible model." Émile Faguet declared shortly before his death that the great mathematician Poincaré was primarily a poet. The new physics is little more than the highway blazed by the constructive imagination of Sir J. J. Thomson and built by the workers in the world's laboratories.

Literature is full of poems and stories which, in their appeal to the constructive imagination of the student, form a sort of

pontoon between literature and engineering and over this the student may pass to a better appreciation of both. I have in mind such poems as Coleridge's "Ancient Mariner," Shelley's "Cloud" and "The World's Great Age Begins Anew," Wordsworth's "The World is too Much with Us" and "Intimations of Immortality," Kipling's "To the True Romance" and "McAndrews' Hymn"; such stories as Poe's "Gold-Bug," Kipling's "The Ship That Found Herself," etc. The list is, of course, only tentative. It may seem a long call from these works to engineering. But is not the common denominator of both found in that great faculty which we call the constructive imagination?

I hope that our committee will criticize freely the three suggestions here made. If the third suggestion is thought wise, I move that a committee be appointed, representing equally English and engineering, to consider the matter more in detail.

C. ALPHONSO SMITH.

EDGAR ALLAN POE SCHOOL OF ENGLISH,
UNIVERSITY OF VIRGINIA.

THE ATTITUDES OF ENGINEERING SCHOOLS TOWARD ENGLISH.

It is not possible to compile a statistical statement of the "attitudes" of different engineering schools toward English that would have any value from the answers to the questionnaire sent out last year by Committee No. 12. According to the replies to questions under this head, almost every school takes almost every attitude. The ambiguity of the returns is doubtless as much the fault of the questions as of the men who were so kind as to answer them. However that may be, it seems that the most feasible method of dealing with the question in this preliminary report is to abandon statistics and to state briefly the two or three attitudes toward the subject which stand out most clearly, as a basis for further discussion.

A few engineering schools ignore English entirely except in their entrance examinations. Their action is based on the

theory that the place for instruction of this kind is in the preparatory school and that no time can be spared for it from the engineering course. Schools which take this view are of course distinctly in the minority, an overwhelming majority taking the opposite position and requiring from one to four years of English of all their regular students.

In a great many institutions the sole aim of instruction in English is proficiency in writing. While many composition courses, especially in the state universities, are run on exactly the same lines as elementary college courses, there is a growing tendency to give engineering students not general composition but instead some kind of instruction in technical writing. The terms "typist English," "engineering English," and "business English" have received a good deal of abuse in different quarters, but they represent substantially the aim of English courses in an increasing number of engineering schools.

When English is taught from this point of view, reading tends to become a study of models of style rather than a training in thought. About half the engineering schools give no instruction in literature at all. Their attitude is apparently that what they want from English is proficiency in writing and that attitude, as has been indicated, runs through much of the instruction in literature where such instruction is given.

In schools where English literature is taught from the liberal and human point of view, the " attitudes " still seem to differ. One point of view is that while literature and engineering may have little to do with one another it is yet worth while to give the engineering student some instruction in literature for the sake of enabling him to take part in " general conversation " or for the sake of giving him access to a refined form of pleasure for his idle hours.

On the other hand, in many schools, English is taught as a means of broadening the student's outlook, of humanizing him, of supplying a liberal element in his education, not merely for the sake of improving him as a man but also as a

means of making him a better engineer. Whatever may be thought of its importance, it is evident that this aim is more difficult to realize than that of giving the student merely proficiency in technical writing. The question between these two aims is perhaps the most important question in regard to English in engineering schools today. While the two attitudes are not antagonistic they are distinctly different and the man is perhaps rare who fully appreciates both.

Both points of view indicated in the preceding paragraph respond to demands of the engineering profession. Practical engineers never cease insisting that the graduates of technical schools should be able to write better English—better reports and business letters and technical articles and books. That demand is one of the most real and important of the many requirements made of the technical schools. And the recent investigation of Dr. C. R. Mann for the Carnegie Foundation and the national engineering societies shows that the profession is demanding no less insistently technical graduates with a broader and more human point of view who can meet and solve the many human problems which arise in the administration of engineering and industrial works.

It would be most illuminating if the discussion at the meeting of the Society could be so directed as to bring out the opinions of a large number of men as to the relative importance of these points of view.

FRANK AYDELOTTE,
MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

THE EMPLOYERS' OPINION OF THE ENGLISH OF THE RECENT GRADUATE.

ENGINEERING MANAGER

.... COMPANY

.... CITY

Dear Sir: Several committees of the Society for the Promotion of Engineering Education are undertaking a general investigation of engineering education. As a member of the committee on English I have been asked by our chairman to write to twenty-five of our leading employers of recent engineering-school graduates for certain information.

Will you kindly let me know whether these young employees are equipped with a knowledge of English sufficient for the work they are called upon to do and, if not, wherein they fail? The committee also wishes to know whether you have any definite recommendations to make as to the courses we are offering or should offer our students so as to make them better qualified to meet the demands placed upon them.

Any information or suggestions you may send me will be appreciated. In case the results of our inquiries appear in printed form, I shall be very glad to send you a copy.

Yours sincerely,

J. M. TELLEEN.

Copies of this letter were sent to twenty-five engineering companies selected from three lists submitted to me by three prominent engineers of Cleveland. From the letters sent out were received fifteen replies, one of which contained three anonymous expressions of opinion of "certain of our men acquainted with this subject."

The letter, though addressed in each case to the "Engineering Manager," brought replies from three secretaries, two administrative managers of the engineering department, two managers of the educational department, a chief mechanical engineer, a mechanical engineer, an assistant general superintendent, an assistant general sales manager, a factory manager, a station betterment engineer, and two whose positions were not given.

Adequacy of the English of the Recent Graduate.—To the question, Is the recent engineering-school graduate equipped with a knowledge of English sufficient for the work he is called upon to do?, two answered in the affirmative, eight answered with a positive "No," and the others expressed themselves as dissatisfied with the ability of the average graduate to use the English language.

Among the eight companies that expressed themselves as quite dissatisfied are included those employers that are known to place the most severe demands upon their engineers. They are companies of a recognized high professional standard. Excerpts from two of the letters from their number are illuminating: "Selecting with great care the technical grad-

uates that come to our company, we probably have less criticism to offer, but at the same time many of them are evidently deficient in their use of the English language, either oral or written." "Personally, I think that more engineers are failing to live up to their fullest usefulness due to their lack of English preparation than through their shortcomings along strictly technical lines."

Causes of the Deficient English of the Recent Graduate.—In their answer to the question, Wherein do the recent graduates fail in their use of English?, the engineering managers were by no means unanimous. The defects that were more frequently emphasized than any others were: use of incorrect grammatical expressions, inability to think logically and to arrange material systematically, lack of conciseness.

Other attributed causes of failure were: unpractical English courses offered in high schools, lack of interest in English in college, failure to realize the importance of English in college and immediately following graduation, no facility in expression in spite of a knowledge of the rules of composition, lack of speed, use of the colloquialisms of the region in which the college is situated, unwillingness to master all the details of the business, failure to get the point of view of their several audiences and to speak in the language of each audience, lack of accuracy, lack of clearness, inability to prepare reports, inability to dictate letters, ignorance of the mechanical form of a business letter, inability to express themselves orally, inability to spell, inability to punctuate, inability to tabulate facts and figures and to represent these graphically, inability to write legibly.

Among the interesting comments on the deficient English of the young engineer are the following: "Very few of the younger graduates seem to realize the importance of systematically and logically organizing the oral or written presentation of every-day matters." "A man may do excellent work in the field and if he is not capable of writing a clear report, well expressed, grammatical at all points and the construction of such that it brings out the fine points of the investigation,

or whatever the work may be, his efficiency suffers by a large percentage. Better training in this respect would give him a larger vocabulary and prevent the repetition of the same word so frequently as to be a blemish to the report.''

Recommendations.—In order to improve the English of the engineering-school student the managers of the engineering companies offered the following recommendations: more thorough training in English should be given the prospective engineer before he enters college; a college entrance examination in English grammar should be required; special efforts should be made in the freshman year to overcome the defects in expression of the student; the written work required by the engineering departments should be submitted to the department of English for criticism; the students should be graded for the English they use in the recitations of all departments, the same weight should be given to correctness in the English of experimental reports that is given to exactness in mathematical calculations; special classes should be organized for those students that are deficient in English; more attention should be given in engineering colleges to English composition and public speaking; the students should be urged to read standard classical English works, such as English essays; courses in business correspondence should be offered; means should be adopted to teach the students facility of expression rather than a mere knowledge of rules.

Two of the engineering managers expressed themselves in favor of a broader training in the following words: ''I am still hoping that the time will come when an engineering degree will be on a full parity with the other professional degrees, and require the much broader training obtainable in a six-year university course.'' ''If I were going through college again, I should endeavor by all means to take what is commonly termed the five-year course, since by so doing I would feel that the studies undertaken in addition to the regular four-year technical course would be of such a nature as to be of great value in the future. There is so much to be absorbed

in the four-year technical course that it leaves very little time for a comprehensive study of English literature, and some of the other subjects tending toward a broader education. I am of the opinion that, if the students of a technical school could be made to appreciate the fact that a technical education is only part of their education and that the other part depends upon their general breadth, we would find more graduates of engineering schools in charge of important work of various kinds.''

Conclusions.—Quite naturally, the replies sent by the engineering managers were not worded in such a form as to make possible a precise tabulation. The nature of the questionnaire letter that was sent them and the character of the information sought did not assure any marked unanimity. However, all the replies were highly illuminating. Almost without exception they revealed the ideals and the problems of the several companies.

As a teacher of English I naturally can not forego the opportunity to quote the following incomplete sentences taken from three separate letters: ''I regret that reply to your letter of January 18, regarding instruction of men in Engineering Colleges.'' ''Replying to your letter of January 24.'' ''Replying to your favor of February 1, beg to state that we employ very few engineers who are recent graduates of technical schools.'' A letter which brings out the hackneyed expressions which are, I believe, rapidly disappearing reads as follows: ''Replying to your favor of the 1st inst., inquiry from our technical department indicates that as a rule young engineering employes occupying positions with us have been found equipped with a sufficient knowledge of English for the work they have been called upon to do. We have no suggestions or recommendations to make in connection with the lines of education best adapted to such young men.''

In contrast to these quotations I shall offer the following excerpt for its form and content: ''It may interest you to know that a class in business correspondence has just been formed in our works and will start its work this week. This is a corre-

spondence and lecture course of sixteen lectures and sixteen assignments. The first class will consist of thirty men, including the superintendent and assistant superintendent, the two principal men of the production department, the sales manager and three or four of his assistants, the managers of four allied or subsidiary organizations, the administrative head and five division heads from the engineering department, the auditor, and several other men of fairly high executive positions."

J. M. TELLEEN,

CASE SCHOOL OF APPLIED SCIENCE.

Teachers who have not already contributed are urged to send in suggestions at the earliest possible date.[1]

Respectfully submitted,

SAMUEL C. EARLE, *Chairman*,

Per C. W. P.

[1] Professor Earle has just left the hospital after undergoing a very serious operation. He had no opportunity, therefore, to prepare a general statement on his own account, regarding the work and plans of the Committee.—EDITOR.

REPORT OF THE COMMITTEE ON ECONOMICS.

Your committee, which was appointed at the annual meeting of 1915, makes the following report:

There have been four meetings held, the number of members present varying from two to four. At the first meeting there was prepared and sent to your Secretary, for distribution among all the technical schools of the United States and Canada, a questionnaire relating to the status of the teaching of economics. Replies were received from sixty-seven institutions; and these were summarized on specially prepared forms, then the latter were blue printed. Accompanying this report is a set of the blue prints, marked "Exhibit A." From these and the replies themselves the résumé marked "Exhibit B" has been prepared. It gives a digest of the information received, looking at the question from all points of view.

As a result of our inquiries and of the long interchange of opinion by letter and in meeting, the committee comes unanimously to the following conclusions:

First.—A knowledge of economics by engineering students, especially of the human element in industry and engineering work, is essential to greatest success in life. Former standards of technical perfection, having no regard to expense of construction, operation, and service, no longer hold. Engineers have learned from experience how to work with inadequate facilities. They have had to meet new and trying conditions. Consequently attention has been given to the economic and social factors affecting engineering projects; and applied economics has had an extensive development.

Unfortunately, though, proper cognizance has not been taken of this important fundamental necessity when determining the details of the curricula in engineering schools. Young men have been left to learn what they can about the subject little by little after graduation—too often at the ex-

pense of those who pay for the constructions which they design and supervise. The opinion is general that the additional study of economics is a great and growing need in any educational plan.

Second.—The necessity of applying the principles of economics in engineering is generally recognized. Economics, therefore, should be an obligatory—not an optional—subject for engineers. The engineering student is likely to overestimate the value of the narrower and more technical features of his training, and to underestimate those things which help to give a broader view. The engineering schools in large part are preparing men for the positions of leadership in engineering enterprise. For this a broad economic outlook is needed.

Third.—We do not now favor an economics course for freshmen. It is difficult even to find room for the subject in the sophomore year, already so overcrowded, although for some reasons it would be advantageous to start teaching it then. However, the commencement of the study of economics should not be later than the beginning of the junior year, so that an opportunity may be given to continue it into the senior year.

Fourth.—Engineering students should take both a course in the principles of economics, such as is given in the academic departments of the leading colleges and universities, and a course in the application of economics in engineering. Concerning the question as to which of the two should come first, there may be a division of opinion. The logical method appears to be that a course in the principles of the subject should precede, and be followed immediately by the special course in the application.

Furthermore, as an introduction to the general course, it is desirable that engineering students should be given in the sophomore year a thorough course in commercial or economic geography and industrial history.

Fifth.—In every practical course in engineering, *i. e.*, in all lines of technical activity which involve designing or construction, there should be given lessons in close detail upon the

economics pertaining to the special branch of work. It is recognized that text-books suitable for such instruction do not yet exist; but the need might be met by a series of lectures. If the engineering teacher is not prepared himself, the school can seek and obtain the aid of specialists in the line of activity which he expounds.

Engineering instructors in all branches of the profession should possess a broad knowledge of the principles of economics. If any such teacher has not pursued this line of study, he would do well to avail himself of all opportunities to extend his knowledge.

Sixth.—A satisfactory course in the principles of economics would require at least a full year of three hours per week; and even this permits of a very brief treatment of many important questions. This is the shortest course which any engineering school should provide; but if in any case to do so is entirely impracticable, an earnest endeavor should be made to approach it as closely as possible.

It must be recognized that one of the great obstacles to the broader training of engineers is the limited time of the four-year course. The range of subjects in both engineering and economics has extended so greatly that increasing difficulty is found in attempting to include them now in a four-year course.

Seventh.—It will be seen that this program provides for four distinct types of instruction.

1. Preliminary study in commercial geography and industrial history;
2. Fundamental course in principles of economics;
3. Application of principles to engineering;
4. Lessons upon special application in detail engineering work.

The committee recommends that, after a discussion of this report and the adoption of a program by the Society, a new committee be appointed to prepare a definite content and scope of the courses, to be followed by a statement of the curricula and syllabus, in order to provide for putting into effect such courses as may be adopted by the Society.

SUPPLEMENTARY REPORT ON ECONOMICS.

This is by no means a minority report, for the writer thereof agrees heartily with all the conclusions of the committee, the members of which are now in entire accord on all matters considered, after having discussed at great length many mooted points; but it is a *supplementary* report, or something in the nature of a corollary. It is true that the fundamental suggestion it contains was made to the committee, but it was not deemed advisable to include it in the formal report; hence the writer makes it upon his own responsibility.

Briefly stated, it is that the Society undertake the compilation into book form of a large number of monographs to be prepared by the most eminent American or Canadian specialists, one in each division or subdivision of engineering, all of the said monographs being edited and introduced by a special committee of the Society, and treating, in as complete a manner as practicable, of the economics of design and construction in the various lines. The book (which might very properly be called "The Economics of Engineering") should begin with a full "Introduction" explaining the *raison d'être* of the work, giving a history of its compilation, and offering suggestions as to how best it may be utilized, both in its own form and in smaller derived books.

This chapter should be followed by one which treats fully of the fundamental economic problem underlying every important engineering enterprise, viz., its financial probabilities and possibilities—in other words, whether the project under consideration would prove to be a profitable investment.

Following this should come, preferably in their alphabetical order, the before-mentioned treatments of the economics of design and construction in the various engineering specialties.

Such a treatise would constitute an encyclopædia of prac-

tical information on one of the most important features of modern technics. It would be invaluable to both the practicing engineers and the teachers of engineering; also to the better class of engineering students, or those of them who are not afraid of hard work—especially post-graduate students. But in order to make its contents of use to the average student, it would be necessary to prepare from it text-books of a simple character. Should the Society favor having such a treatise issued under its auspices, a publisher of established reputation could undoubtedly be found to finance the undertaking and issue the work at his own expense—preferably without paying any royalty, in order to keep the selling price down to a minimum.

A short time ago, by the request of the dean of the engineering department of the University of Kansas, the writer prepared and delivered a course on "Engineering Economics" in three lectures to the engineering faculty and students of that institution. The university has lately published these lectures in pamphlet form; and the writer has placed a few of them at the disposal of this meeting. The first lecture deals with the fundamental economic problem of finance beforementioned; the second treats in full and complete detail of the economics of bridge design and construction; and the third is a compilation of certain data furnished by the courtesy of a number of prominent specialists, outlining in a general way the economics of design and construction in their specialties. The writer would be willing to rewrite and expand the first lecture so as to make it serve for the second chapter of the proposed treatise; and the second lecture could be sent to each of the chosen specialists in order to indicate the extent of the desired thoroughness of treatment of his subject, and to serve otherwise as a guide to him in the preparation of the manuscript. If it were expanded by the writer so as to include the results of the extensive investigation he is now making on the "Economics of Steel Arch Bridges," it would serve for the chapter devoted to the specialty of bridge engineering.

The third lecture, which nowhere aims at completeness,

would prove useful in suggesting some of the salient topics which should be covered in the writings of a few of the specialists.

The preceding proposal is made with all due deference to the distinguished technical educators and practicing engineers of which this Society is so largely composed, in the hope that it will meet with a favorable reception and will prove to be the means of materially augmenting the amount of available technical knowledge in a line of thought which has not received, up to the present time, the consideration which is its due.

Respectfully submitted,

J. A. L. WADDELL,

Chairman.

REPORT OF COMMITTEE ON MINING.

PRELIMINARY REPORT ON RESULTS OF QUESTIONNAIRE.

We believe there are thirty-four schools in the United States and Canada that give laboratory instruction to undergraduate mining engineers. Twenty of these have replied to the questionnaire with answers; one is considering a reorganization of its courses and is not now prepared to give answers; a few have given references to heads of departments from whom we expect to receive replies; and, no doubt, we shall hear from some who have not yet replied at all. Moreover, we believe the replies already received give a good representative average of American mining school practice.

PERCENTAGE OF MINING SCHOOLS IN WHICH LABORATORY WORK IS REQUIRED OR ELECTIVE IN VARIOUS SUBJECTS.

Subjects.	Required.	Elective.
(1) Assaying and analysis	95	none
(2) Ore dressing	90	5
(3) Metallurgical	80	10
(4) Mining (including field work, surveying and otherwise, aside from inspection trips)	85	5
(5) Other laboratories (including all general engineering laboratories and field surveying). Give number of hours in each and indicate whether required or elective:		
(*A*) Mechanical—"shops"	70	10
(*B*) Electrical	80	15
(*C*) Hydraulic	35	15
(*D*) Power	65	20
(*F*) Surveying	95	none
(*G*) Compressed air laboratory	5	5
Mine gases and mine ventilation laboratory	5	10
Strength of materials	15	5
Mining coal	5	none

Average Laboratory Practices.

Laboratories.	Per Cent. in Proper Column by Whom Prepared.		Operated.		Clean-up is Made.			Remarks.
	Student.	Instructor.	Student.	Instructor.	Student.	Instructor.	Janitor.	
(1) Assaying......	51	49	97	3	84*	9*	7*	Apparatus consisting of sampling and grinding machinery, furnaces, etc.
(2) Ore dressing.	66	34	96	4	85	15		
(3) Metallurgy...	62	38	87	13	77	23		

*Cleaned as distinguished from clean-up in other laboratories.

Mining Laboratory.

The various divisions in which laboratory instruction is given, and the respective importance (by per cent.) of each.

Division.	Req.	El.	Remarks.
(a) Drilling	65	5	The percentage is obtained by dividing the number of schools giving the instruction by the total number of schools reporting.
(b) Explosives..........................	45		
(c) Timbering (supporting)..........	40		
(d) Mine gases, safety lamps, and explosibility of dust...........	30	5	
(e) First aid and rescue	55	10	
(f) Work in mines......................	25	5	
(g) Metering air	5	5	
Sampling, etc..	5		
Ventilation..........................	5	10	

AVERAGE LABORATORY USES AND PRACTICE IN PER CENT.

Answer in Each Column to Which Question Applies for Each Laboratory.	(1) Assaying.	(2) Ore Dressing.	(3) Metallurgy.	(4) Mining.
Is the course illustrative (work done by the instructor)	9	8	13	10
or				
Is the work done by the students	91	92	87	90
Is the laboratory work individual	93	92	90	91
or				
Is it in units	7	8	10	9
Does the student follow printed directions	40	63	37	44
or				
Is he dependent on his own initiative in carrying on the work	60	37	63	56
Does the student prepare his own material for the tests *	32	58	17	
Does the student prepare his reagents*	26	32	50	
Does the student analyze his products (2) and (3)*		74	78	
Is most of the work illustrative (2) and (3)		30	18	
or				
Is it determinative and quantitative		70	82	
Is especial attention given to any class of ores, or the ores of any particular metal (1), (2) and (3)	8	17	25	
or				
Is the work of the laboratory generalized	92	83	75	
Do the students make their tests with individual machines or furnaces (2) and (3)	73	57	64	
or				
Do they run several machines or furnaces in sequence at once	27	43	36	
Is the laboratory equipped for commercial testing work (2) and (3) and (4)*		74	75	6

* No. per 100.

AVERAGE ACADEMIC USES AND PRACTICES IN PER CENT.

Answer in Each Column to Which Question Applies for Each Laboratory.	(1) Assaying.	(2) Ore Dressing.	(3) Metallurgy.	(4) Mining.	All Labs.
Approximate apportionment of student's time:					
A. At instructions:					
1. Reading assignments	10.2	15.0	13.9	13.7	13.5
2. Printed or written matter	6.4	2.0	3.5	2.2	3.5
Oral and illustrative—					
3. In recitations	7.1	8.8	7.4	2.7	6.5
4. In lectures	12.4	20.1	27.5	12.5	18.5
5. In laboratory	8.6	9.3	7.9	13.7	10.0
B. At work:					
1. On experimentation	46.6	33.5	30.5	32.2	35.0
2. At mere manual work, such as shoveling, etc.	2.3	1.1	1.1	11.5	4.0
C. At writing report	6.4	10.2	8.2	11.5	9.0
	100	100	100	100	100
Are the laboratory hours regularly scheduled	100	93	100	95	97
or					
Are they adjusted to suit the convenience of other work, from time to time		7		5	3
Does the student originate the style of his report	40	77	70	94	74
or					
Are blank forms used	60	23	30	6	26

AVERAGE PROPORTIONATE EMPHASIS PLACED IN PER CENT.

Per Cent. in Each Column to Which Question Applies for Each Laboratory.	(1) Assaying.	(2) Ore Dressing.	(3) Metallurgy.	(4) Mining.	All Labs.
Proficiency in the use of apparatus—					
Speed	13.1	4.1	4.1	11.7	7.5
Accuracy	32.7	18.4	23.6	19.6	23.0
Knowledge of principles involved—					
Chemical	10.5	6.0	13.6	11.4	11.0
Mechanical	7.3	14.7	12.3	6.8	11.0
Construction	6.4	9.4	6.8	4.8	7.0
Action	8.2	17.2	7.3	10.3	11.0
Understanding of proper field	1.0	9.4	6.8	10.3	6.0
Initiative in new problems	3.6	7.5	4.6	5.7	5.5
Subject matter and arrangement of report	7.7	12.2	13.6	16.0	12.0
Other considerations	9.5	1.1	7.3	3.4	5.5
Total	100	100	100	100	100

REPORT OF COMMITTEE ON CHEMISTRY.

Your committee, which was asked to study the courses in chemistry offered to engineering students, submits the following as to what in its opinion should be controlling ideas in the first-year course of "college grade," usually designated as general chemistry. We should like a continuance of this committee for the study of succeeding courses offered to students of chemical engineering.

There should be, and usually are, four sources of information available to the student: the text-book, the laboratory work, the lectures and parallel reading.

The general objects of the course should be:

(*a*) To develop an efficient and accurately working thinking machine in the head of each student.

(*b*) To teach thoroughly the physical properties and especially the chemical reactions of the commoner elements and typical members of those classes of compounds which are essential to a future growth of a knowledge of the science of chemistry—elements and compounds around which the student can build up chemical knowledge of fact and theory, including those substances which are frequently met with in one's daily life.

(*c*) To teach those more important generalizations which lead to a working comprehension of simple chemical action.

(*d*) To give a broad interest and understanding of what chemistry is and the part chemical knowledge plays in our economic life.

The course should have as its main object to teach the chemical and energy changes in matter and the laws of such, rather than descriptions of pure compounds.

We believe that the textbook should *not* be merely a compound of encyclopædic information regarding physical properties, with incident discussion of reactions arranged around

the elements, taken up in one of another order. It should at first discuss the properties and typical reactions of classes of substances—common metals, common non-metals, oxides, acids, bases, salts—and such characteristic reactions of important individual substances as will give the data for discussions of the simpler fundamental conditions and general laws of chemical action. There should be a carefully limited and logical development of this knowledge, and the continuity should not be clouded by purely encyclopædic information. The latter should be placed in a part of the book to itself, so arranged and indexed as to be readily available in connection with both class-room and laboratory study, regardless of how much repetition of statement this involves. It is better to use printer's ink than to confuse or overwhelm the student by mixed-up information. Cross-references and the index should be looked after with great care. After the preliminary thorough but limited treatment of the more important classes and individual substances, the discussion of general subjects and laws of chemical action can be adequately treated and the subject expanded to suit the individual class possibilities or requirements. The total contents of a first-year text should be only such as can be comprehended reasonably well and *thoroughly learned and remembered* by a first-year college student who really works during, say, 96 hours in lectures, if possible (or 64 lectures and 32 quizzes), 32 hours in oral quizzes, 192 hours in the laboratory, and about 200 to 250 hours devoted to intensive study and parallel reading outside of the classroom, with the usual examinations, and as many written quizzes as the time will justify; in other words, the frequently given three-lecture, one-quiz and six-hour laboratory course during one college session of 32 working weeks.

The selection of the data and its treatment should be such as to call for a minimum of "learning it by heart" and a maximum of remembering it through its use in the solution of live and useful chemical problems. It should utilize previous experiences, and lay a firm foundation for future study. The author of the successful textbook has a difficult journey

to travel; but he must know fully where he is going, what he will need, and how fast and how far his students can reasonably go. He should select his material as an experienced North-woods traveler selects his pack—discarding everything but those items he knows he will need. *A textbook writer may profitably leave much for the lecturer to supply and something for the student to find out through reference to other books and through parallel reading.* The habit of looking up information to solve problems regarding chemical action should be forced upon the student until he learns how to do this, and overcomes what seems to be a natural aversion to this kind of work; because the key to success in after-life is this habit and ability to look up information on subjects under consideration; a person is not educated until he can do this successfully. A maximum of individuality and initiative should be carefully developed. The first-year chemistry course should develop this habit and capacity to a marked degree, and the extent to which it is developed is the measure of the success of the system of instruction. The most successful courses are those which go over the ground twice—as a surveyor goes twice over a new territory, running a preliminary line first, and supplying new and desirable details through a second survey.

The golden mean should be observed between too much nursing of the first-year college student and throwing him too much upon his own resources. But the student *must be forced to do his own thinking* and be helped and stimulated by carefully offered suggestions. The teacher should stir up interest, but the student must supply much of the energy, and develop knowledge by painstaking work.

The textbook and laboratory manual should coördinate intimately but not necessarily run parallel; the whole text and other literature are at the service of the student from the beginning. Footnote references to the literature are silent and effective instruments of instruction.

The Laboratory Work.—It is through the laboratory work and the study and reading incident thereto that one really

learns chemistry. Two characteristics of the laboratory course should stand out so prominently and clearly that even the dullest and laziest person must see them: First, *that the laboratory period is a period of intensive study*, under ideal conditions for acquiring knowledge, and secondly, the laboratory is for the first-year student exactly what it is for the research chemist, *a place where he finds out chemical facts which he does not learn or cannot learn so well from books or people.*

From start to finish the laboratory work should be framed around the solution of problems. These should be full of life and very suggestive, but not "made to order." These should teach early the point of view of the course and the methods of procedure common to the solution of simple problems. Each problem should be built upon previous experience either at home, outside college, or the knowledge already acquired in the laboratory and classroom. It should constantly suggest something of the subsequent work. There should be a logical sequence throughout the course. Every experiment should lead to *one* clean-cut idea; and as far as practicable important data should be used over and over in different relations and be looked at from different angles until the student finds that it saves time and pays generally to fix the facts in his mind from day to day. His progress should be clear to himself, for if he sees that he is gaining power to solve problems and comprehend chemical relations, he will feel that he is "getting somewhere," and his work will encourage him to attack yet harder problems.

The laboratory course should train the hands to help the brains, and the brains to help the hands, the "make your head save your heels" principle. An unerring aim should be to build up experimentally a body of knowledge of fact necessary for a comprehension of the laws of chemical action and the relation between matter changes and energy changes in a system. This necessitates that emphasis be laid always upon the reactions which are taking place, the "conditions" which influence the change, and those physical properties, mass and energy factors which control the equilibrium of "chemical

forces." In fact, the laboratory course, even more than the lecture course, should emphasize the *chemical reactions* of substance, and their physical properties in so far as a detailed knowledge of these leads to other chemical knowledge. If handled properly the more important physical properties of pure substances will be firmly fixed in the student's mind, because they must be *used* in identifying the nature of the chemical change and in explaining its mechanism and control. If "conditions" are also handled incidentally to the study of the chemical process they too receive more attention, and are remembered better. It is a good plan to mention as little as possible the apparatus to be used and its arrangement. If the conditions to be maintained are carefully suggested and the student compelled by circumstances to look up the physical and chemical properties of the reagents and possible products, he will select his apparatus as a carpenter selects his tools—to accomplish a purpose, and the purpose will become the prominent thing in his mind. Too much specialization in the apparatus and the laboratory arrangements for first-year students is apt to give a too unfamiliar atmosphere to the laboratory, attract too much of the student's attention, increase the cost and generally hinder his progress to a certain extent. The laboratory should be conveniently equipped, but not enough so to retard a *tendency to study experimentally wherever the student finds himself and with any apparatus that may be at hand.* The student's and the teacher's time is an important consideration, but not the thing of even second importance.

Both the nature of the experimental work and the equipment should lead the student to "eat, drink and sleep" chemistry outside of regular hours. It should promote disputation of fact and explanation among the members of a class, and enable each one to prove or disprove his contention, to find out the truth for himself.

The whole chemistry course should incite men to read for further information. It should introduce them to chemical literature and the use of encyclopædias and other sources of information which are accessible in after-life.

So much for the intensive parts of the course in general chemistry.

The extensive and broadening factors lie in parallel reading, the lectures and personal contact with an inspiring and helpful teacher. "Reading maketh a full man," and a good teacher teaches and guides to higher thoughts and a knowledge of how to surmount the difficulties that lie in every road to knowledge.

At the end of the general chemistry course the student should feel that he has really just begun to study the science. He should believe that everybody should take the course, because he has come to see that:

First. The act of staying alive and keeping one's body and mind in a healthy condition involves chemical changes a knowledge of which leads to a better understanding and more intelligent control of eating, sleeping and taking healthful exercise.

Second. That chemistry offers an unusually interesting opportunity to build up an efficient and accurately working mind.

Third. That practically every change in materials during manufacturing processes involves, directly or indirectly, chemical changes or chemical processes an understanding of which leads to intelligent control and economical production.

The second part of this report will deal with detailed experiments and references to textbooks and courses where the above outlined objects and methods are put into successful practise.

R. M. Bird,
J. H. James,
J. R. Withrow,
Committee.

REPORT OF COMMITTEE ON HIGHER DEGREES.

Dear Professor Jackson:

I give below a brief memorandum of the meeting of the Committee on Higher Degrees of the Association of American

Universities held in Cambridge at the Office of Dean Haskins, Graduate School of Arts and Sciences, Harvard University, on November 8.

I attended this meeting as your alternate, representing the Society for the Promotion of Engineering Education. Dr. Kennelly also attended at your request on account of your unavoidable absence. We were present, however, only at the morning session, as we both had to leave town in the afternoon.

Neither Dr. Kennelly nor I have received a copy of the Minutes of the meeting, so that what follows is merely a personal report, from memory, of what took place at the meeting. Dean A. O. Leuschner, of the University of California, presided. The others present were:

Dean C. H. Haskins, of the Harvard Graduate School of Arts and Sciences. Professor George Comstock, of the University of Wisconsin. Dean H. D. Arnold, of the Harvard Graduate School of Medicine. Dean Roscoe Pound, of the Harvard Law School. Professor H. W. Holmes, of the Harvard Department of Education.

The principal subject of discussion was the standardizing of the advanced degrees, to the end that the variety of degrees given be greatly reduced, and that there be a definite distinction between honorary degrees and those given in course. The consensus of opinion was that the degree of Ph.D. should not be employed as an honorary degree but that the Sc.D. without designating the field should be employed for this purpose; also that where it was desired to give the Sc.D. as an earned degree the field should be designated; also that the Ph.D. should be given for work following an academic lower degree and the ScD. in a specified field for work following a more specific undergraduate program, such as implied by the S.B. degree as given by most of the universities and technical schools of recognized standing.

It was urged by Dr. Kennelly that the same disposition be made in regard to the M.S. degree as above indicated for the degree of Sc.D.

I was informed that the afternoon session at which we were absent would not (and did not) farther consider these questions in which we were interested.

I should have made this report earlier had I not hoped to receive a copy of the formal minutes of the meeting.* I understand from Dr. Kennelly, however, that he asked Dean Leuschner to have a copy of the minutes sent to him, and was told that the discussion had not yet reached a stage where that seemed necessary.

Very sincerely yours,
C. A. ADAMS.

* This is printed in accordance with a motion of the Council.

AUGUSTUS JAY DUBOIS.

Augustus Jay DuBois was born April 25, 1849, at Newton Falls, Ohio, and died October 19, 1915, at New Haven, Conn. He took the course in civil engineering at the Sheffield Scientific School of Yale and graduated in 1869. He then pursued graduate studies for nearly four years at Yale and at the Royal Mining Academy in Freiberg, Saxony. After working at surveying for a time, he prepared the manuscript for a book on "Graphic Statics" which was published in 1875. In this year he was appointed professor of civil and mechanical engineering at Lehigh University from which he was called in 1877 to the same professorship at Yale, and after 1884 he occupied the chair of civil engineering there.

During his forty years of service as a teacher, Professor DuBois was active in enriching the literature of theoretic and applied mechanics. His "Elements of Graphic Statics" was the first comprehensive book on the subject issued in this country. He translated works of Weisbach, Weyrauch, and Roentgen on hydraulic motors, steam engines, materials, and thermodynamics. His "Stresses in Framed Structures" was a quarto volume which passed through eleven editions and it was widely used as a text-book in engineering schools. He also wrote three volumes on mechanics and papers for technical journals. In his later years he published lectures on philosophical and moral subjects, which contained novel ideas set forth from a mechanical standpoint.

He was an excellent teacher, always insisting that his students should be thoroughly grounded in fundamental principles. His sympathetic interest and ready wit claimed the attention of his students at the start and to them he was a

devoted friend. He was a man of broad culture and a deep thinker on philosophical questions. He became a member of this Society in 1894 and was also connected with many other societies, but he rarely attended their meetings, seeming to feel somewhat awkward outside of the circle of his friends and students. His disposition was naturally modest and retiring, and his character was of the highest; his life was one of hard work, unrelieved by any sabbatical year.

ALBERT ELLIS FROST.

Dr. Frost was born in St. Johnsbury, Vermont, August 9, 1851. He received his early education in the public schools and in St. Johnsbury Academy. He later attended Dartmouth College and was graduated in 1872 with an A.B. degree. In 1877 he took his A.M. degree and in 1897 he received that of Sc.D. About this time he became associated with Professor S. P. Langley, famous scientist and inventor of the first heavier-than-air flying machine. Professor Langley was at this time located at the Allegheny Observatory. He remained at the Allegheny Observatory for three years from 1872 until 1875. Then he became professor of physics at Pittsburgh Central High School, where he remained for ten years. In 1885 he came to the University of Pittsburgh, then Western University of Pennsylvania, accepting the chair of physics. Three years later, he became registrar, at the same time keeping his professorship of physics. He held the chair of physics from 1885 until 1908. He was also acting dean of the school of engineering and the college and professor of mathematics from 1908 till 1910. In addition, he served in the capacity of treasurer for seven years. He was a member of the Society for the Promotion of Engineering Education since 1908. Dr. Frost died May 11, 1917.

SAMUEL CHANDLER EARLE, 1870-1917.

In the passing away of Samuel C. Earle on July 20, 1917, the cause of English in technical schools has lost a pioneer who has rendered a most faithful and notable service. He was born at Brattleboro, Vermont, July 7, 1870. His A.B. degree was taken at Harvard College in 1894 and in 1895 he received the A.M. degree from the same institution. During this year he was appointed Assistant Instructor in English at Tufts College, and in 1896 was made Instructor. He was advanced to Assistant Professor of English in the Engineering School of Tufts College in 1902, and to full Professorship in 1906.

During the fifteen years in which he held this chair, he rendered a unique service for the advancement of English in technical education, and to him is largely due the present method of teaching English in engineering schools.

More than a decade ago he abandoned the old methods of teaching English by "formal Rhetoric," and inaugurated his plans for making the subject of English vital to the development of technical education by creating a really live interest on the part of the student. To this end he rewrote the English Grammar, making it an International Grammar; he taught the student to think before trying to give expression to thought; he humanized the subject of English, and created an enthusiasm on the part of his students and teachers.

He was the author (with H. J. Savage and F. E. Seavey) of "Sentences and their Elements," "The Theory and Practice of Technical Writing," and of various articles in the *English Journal*, ENGINEERING EDUCATION, the *Educational Review* and other periodicals.

Professor Earle's work was conducted with such a degree of modesty that even the members of his own faculty were not aware of the extent of the propaganda which he carried on in the interest of technical education. He was a sympathetic and painstaking teacher, an inspiring and loyal friend to his associates; an organizer of unusual ability; a seer of educational vision.

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